ENGINEERING NEWS-RECORD

NOVEMBER 1, 1945

VICTORY LOAN

BUY BONDS

Featured In This Issue

HIGHWAY SNOW AND ICE REMOVAL METHODS

BYERS WROUGHT IRON *HELPS* to control pool levels . . . and to control corrosion too

Every engineer concerned with lock or dam construction must face the fact that corrosion is always an actual or a potential threat, which must be forestalled if excessive maintenance is to be avoided. In many instances surface coatings cannot provide the final answer, either because of ineffectiveness or because of the cost or difficulty of frequent application. In such cases, wrought iron has been widely and successfully used, and its durability is a matter of confirmed record.

A promising extension of this use is in roller gates like the one pictured. Wrought iron is readily fabricated, has ample strength to withstand the impact of floating debris, and has unusual corrosion resistance that does not depend on surface coatings, but which is inherent in the material.

In one reported instance, a wrought iron roller gate was repainted only once during 11 years of service. Since each paint job required the installation of a coffer dam, it was an expensive operation, amounting to an estimated average of $1000 per gate per year. The savings on this maintenance item alone would speedily pay the extra cost of wrought iron, even without the extra life that past experience suggests may be expected.

Wrought iron's independence of surface coatings for protection is due to the fact that it develops its own protective film. The tiny fibers of glass-like silicate slag that are threaded through the body of high-purity iron halt and diffuse corrosive attack, and also help to firmly anchor the initial scale which develops. This tightly adherent scale shields the underlying metal, as a scab shields a wound.

A number of lock and dam installations where wrought iron has been used are illustrated and described in our bulletin, "Wrought Iron for Bridge Construction." Our Engineering Service Department will be glad to supplement this information with details on any specific applications in which you are interested. May we send you a copy of the bulletin?

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McGRAW-HILL PUBLISHING COMPANY, INC.

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WALDO G. BOWMAN, *Editor* ALBERT E. PAXTON, *Publisher*

..., 135 NOVEMBER 1, 1945 No. 18

...OMING NEXT

The new Pecos River railway ...ge in southern Texas is a spec...lar structure of continuous deck ...tilever type, with a 375-ft. main ...n over a deep rocky gorge. The ...n is carried on hollow concrete ...s, the tallest of which is 275 ft. ...se piers were built with slip ...ns, concrete being delivered by ...eway, and the superstructure ...tion was by cantilever methods ...ed by jacking over the piers. The ...ject will be described in the Nov. ...issue.

Investigation of structural be...ior of Fontana Dam is being ...ried on with the aid of special ...suring instruments. Meters are ...talled across longitudinal and ...nsverse joints to determine ...anges at contraction joints, to ob...ve movements of adjacent blocks ...ring grouting and to check subse...ent changes. Installation and ...cking procedures will be out...ed in the Nov. 15 issue.

Recent development of reliable ...terproof glues and laminating ...chniques for timber construction ...s spurred interest in the strength ...operties of such timber members, ...d in their treatability with preserv...ves to materially increase service ...e under severe exposure. To an...er these questions a series of tests ...re undertaken and the results will ... reported in the Nov. 15 issue.

...OOKING AHEAD

Design of a new four-lane suspen...n bridge with a 2,800-ft. span to ...place the Tacoma Narrows Bridge, ...ich collapsed in 1940, has now ...en completed. The design is based ... a four-year research program in ...pecially constructed wind tunnel. ... full-length scale model was built ...d tested to determine, not only ... effect of wind but the possibility ... vibration resulting from aerody...mic forces. The design and test...g procedure will be discussed in an ...rly issue.

Designed in 8-ft. linear modules, ...merous prefabricated one-story ...my hospitals have been built in ... Pacific theater. Constructions ...sist of a bolted framework of ...et steel formed to structural ...pes, and an exterior covering of ... wide panels of 24-gage sheet ...tal, factory punched to permit ...id assembly. These structures ...d methods of erection will be de...ibed in a forthcoming issue.

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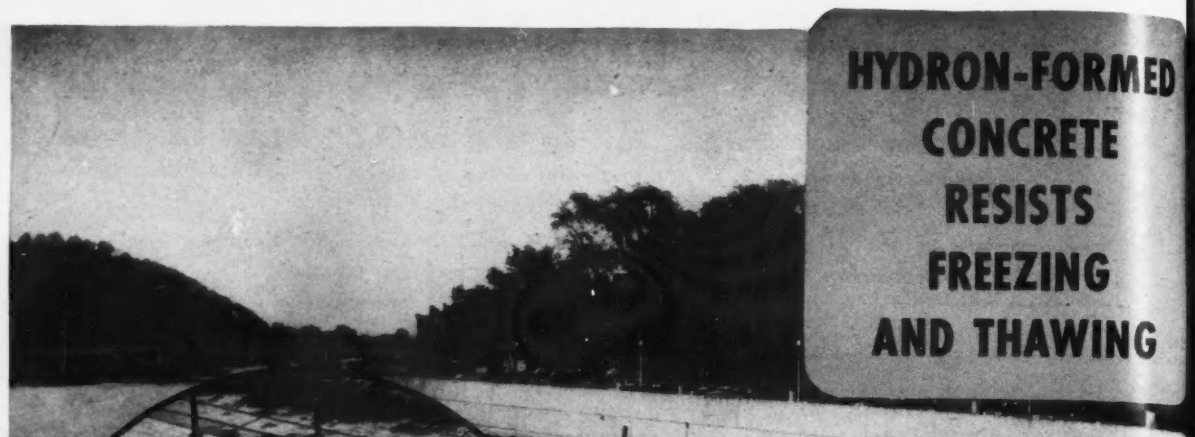

SUSQUEHANNA FLOOD WALL LIKE NEW AFTER FOUR YEARS OF FREEZE-THAW CYCLES

THESE ARE PICTURES of the Susquehanna flood wall at Binghamton, N. Y. taken last summer. Despite four years of frequent freeze-thaw cycles, the wall still looks like new.

Here's the reason: the wall was cast against Hydron absorptive lining, which reduces by 30% the absorption of water by concrete. Hydron also greatly reduces or eliminates such surface defects as air pits, water channels, and sand streaks.

Tests show conclusively that Hydron produces a case-hardened concrete surface that withstands four times as many freeze-thaw cycles as samples cast against wood.

Before Hydron was ever used on such projects as the Susquehanna Flood Wall, or the new MacArthur locks in the "Soo" Canal, or the Norfork Dam, it underwent years of analysis and testing by United States Rubber Company in laboratory and in the field. The lining was not offered for sale until experts in concrete technology and construction had examined and approved it.

Hydron's case-hardening effect is at least one inch deep, with a gradual change in the water-to-cement ratio and density from the surface into the bulk concrete.

Made in thin, flexible sheets, Hydron is mounted to forms with rapid-fire staple guns. Hydron strips cleanly, needs no tedious finishing.

Send for your copy of informative booklet on Hydron

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New Construction in October

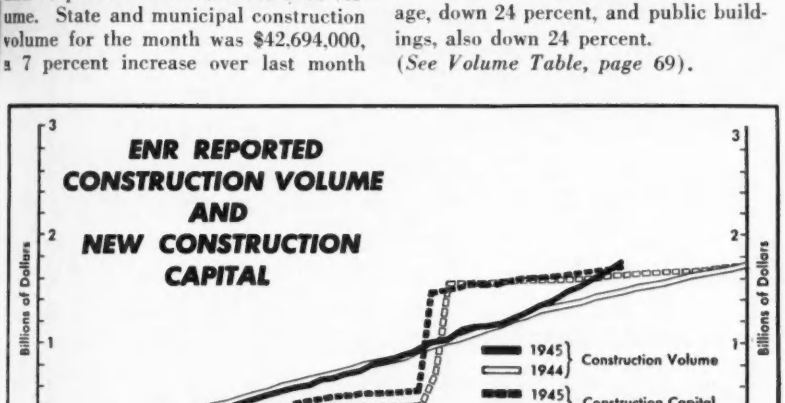
CIVIL ENGINEERING construction volume climbed to $239,436,000 in October, with an average of $59,859,000 for each of the four weeks of the month. This average is the highest weekly average volume reported since July 1943. Private construction continued to climb and reached the five year peak of $178,183,000, being topped only by the prewar, private construction volume of the early months of 1940. Federal work, on the other hand, dropped to the level of April 1940 and is at the lowest volume figure in five years. The October weekly average volume is but 2% higher than the four-week average of September, however, it is 88% greater than the four-week average of October 1944.

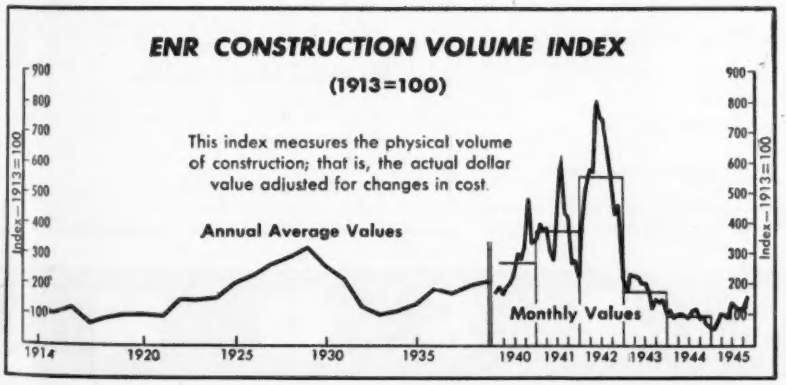
Private construction, on the weekly average basis, tops last month by 6 percent and soars 695 percent over the average for October, last year. Greatly increased activity in both industrial and commercial building is responsible for the rise in private work. Public construction, 9 percent below last month and 41 percent below last year, results mainly for the drop in Federal work which is 33 percent below last month and 76 percent below October 1944 volume. State and municipal construction volume for the month was $42,694,000, a 7 percent increase over last month and 84 percent over the 1944 figure.

October construction total brings the 1945 cumulative figure for the ten months to $1,735,690,000, a 15 percent increase over 1944. Private construction, $739,947,000 this year, records a 136 percent gain over 1944. State and municipal construction for this period was $301,276,000, a 41 percent gain over last year. Public construction, and federal construction, both dropped 17 and 29 percent, respectively, below the 1944 period.

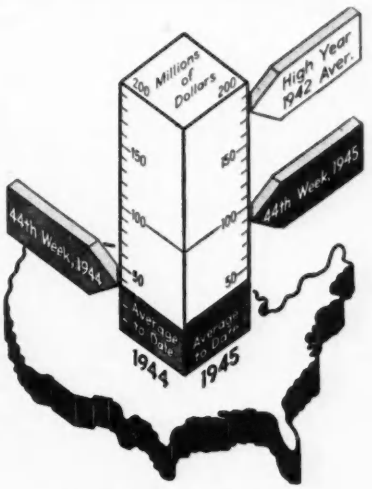
Industrial building with a ten month volume total of $437,649,000, tops any of the war year totals for a like period, and is 195 percent over the total for ten months of 1944. Bridge construction volume of $33,603,000, also gained strongly, showing a 143 percent increase over the total for last year, and waterworks and sewerage showed welcome raises over 1944. Waterworks and sewerage were 64 and 5 percent respectively, over the volume of 1944. Highways and commercial buildings also were gainers over last year, the latter showing a 71 percent increase. Unclassified construction dropped 11 percent compared with last year, as did earthwork and drainage, down 24 percent, and public buildings, also down 24 percent.

(*See Volume Table, page* 69).




ENR CONSTRUCTION VOLUME INDEX
(1913=100)
This index measures the physical volume of construction; that is, the actual dollar value adjusted for changes in cost.
Annual Average Values
Monthly Values
Index—1913=100
1914 1920 1925 1930 1935 1940 1941 1942 1943 1944 1945

CONSTRUCTION ACTIVITY



As Reported This Week to...
Engineering News-Record

CONTRACT VOLUME

Continental U. S. Only
(Thousands of Dollars)

	Week of Nov. 1 1945	Cumulative 1945 (44 wk.)	Cumulative 1944 (44 wk.)
Federal	$10,167	$704,634	$1,001,386
State & Mun.	10,192	311,468	218,300
Total Public	$20,359	$1,016,102	$1,219,686
Total Private	67,439	807,386	319,463
U. S. Total	**$87,798**	**$1,823,488**	**$1,539,149**

WHERE CONSTRUCTION ACTIVITY ORIGINATED THIS WEEK

Type of Work	Dollar Volume (Thousands) This Week	Cumulative 1945 (44 wk.)	Cumulative 1944 (44 wk.)
Waterworks	$4,513	$49,848	$28,109
Sewerage	1,034	29,367	27,436
Bridges	2,590	36,193	14,363
Highways	4,612	19,621	176,389
Earthwork, Waterways	1,780	47,003	61,284
Buildings, Public	4,365	432,438	582,999
Industrial	20,601	458,250	152,369
Commercial	45,077	250,139	122,087
Unclassified	3,226	327,970	374,113

NOTE: Minimum size projects included are: Waterworks and waterway projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1945 (44 wk.)	Cumulative 1944 (44 wk.)
NON-FEDERAL	$669,033	$397,996
Corporate Securities	170,496	96,970
State and Municipal	334,937	160,086
RFC Loans	24,600	57,940
REA Loans	60,000	20,000
Fed. Aid Highway	79,000	63,000
FEDERAL	$1,049,898	$1,263,800
Total Capital	$1,718,931	$1,661,796

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Nov. '45	308.28	148.69
Building Cost	Nov. '45	240.55	130.00
Volume	Oct. '45	167	73

Hi-Bond Bars Formed to Exact Specifications

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Make Ryerson your source for construction steels. Large stocks are ready for shipment from our eleven plants (Hi-Bond Re-Bars are carried in Chicago, Detroit and Cincinnati). We have complete facilities for preparing steel to meet your needs . . . engineers to assist you in supply or design problems . . . a nation-wide organization to work with you in every step from estimates to final delivery. Whether it is concrete reinforcing, structural fabricating, or plain material from stock—we can assure prompt, personal service.

We'll be glad to send our Bulletin on Hi-Bond reinforcing

Joseph T. Ryerson & Son, Inc., Steel-Service Plants: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Pittsburgh, Philadelphia, New York,

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A full range of sizes and weights . . . cut to your order and punched, flame cut or otherwise prepared.

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Both mechanical and boiler tubing in all standard sizes.

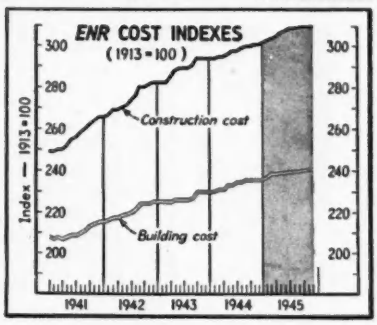
RYERSON

OVEMBER CONSTRUCTION BUSINESS REPORT

ENR CONSTRUCTION VOLUME AND NEW PRODUCTIVE CAPITAL

(,000 omitted)	October 1944	October 1945	% Change	Ten Months 1944	Ten Months 1945	% Change
U. S. Construction	$127,195	$239,436	+88	$1,506,756	$1,735,690	+15
te Construction	22,582	178,183	+695	313,849	739,947	+136
e Construction	104,613	61,253	−41	1,192,907	995,743	−16
al	81,336	18,559	−77	978,480	694,467	−29
New Productive Capital	32,868	65,263	+100	1,645,488	1,714,499	+4
te Investment	32,686	65,263	+100	240,748	501,001	+109
al (non-federal work)	.....	.....	.....	140,940	163,600	+16
al (federal work)	.....	.....	.....	1,263,800	1,049,898	−17
R Construction Volume Index, 3 = 100	91	167	+84	101*	114*	+13

* Ten-month average



ONSTRUCTION COSTS . . . . WAGE RATES . . . . MATERIAL PRICES

	November 1944	November 1945	% Change	Changes October to November 1944 Oct.	1944 Nov.	1944 %	1945 Oct.	1945 Nov.	1945 %
R Construction Cost dex, 1913 = 100‡	301.09	309.28	+2.7	301.06	301.09	0.01	309.28	309.28	0
R Building Cost Index, 3 = 100‡	236.10	240.55	+1 8	236.00	236,10	0.2	240.35	240.55	0.1

‡ *Does not reflect increased costs due to overtime, lower labor efficiency, delivery delays, etc.*

ENR 20-CITIES' AVERAGE

mon Labor	$0.886	$0 917	+3.5	$0.886	$0.886	0	$0.917	$0.917	0
ed Labor (av. 3 trades)	1.641	1.677	+2 0	1 641	1.641	0	1.674	1.677	+0.2
dayers	1.739	1.772	+1.9	1.739	1 739	0	1.770	1.772	+0.2
tural Ironworkers	1.698	1.729	+1.8	1.698	1.698	0	1.727	1.729	+0.2
penters	1.487	1.530	+2 8	1.487	1.487	0	1.525	1.530	+0.3
ent, per barrel	$2.68	$2.76	+3.0	$2.68	$2.69	+0.3	$2.76	$2.76	0
forcing steel, cwt.	2.79	2.79	0	2.79	2.79	0	2.79	2.79	0
tural steel, base	2.10	2.10	0	2.10	2.10	0	2.10	2 10	0
per ton	1.25	1.24	−0.8	1.25	1.25	0	1.24	1 24	0
ber, 2x4 Fir, per M ft	54.58	55.63	+1.9	54.58	54 58	0	55.63	55.63	0
ber, 2x4 Pine, per M ft.	53.44	53.84	+0.7	53.38	53.44	+0.1	53.84	53.84	0
mon brick, per M	17.22	19.58	+13.0	16 99	17.22	+0.1	19.08	19.58	+3.0
y-mixed concrete, c. y.	7.46	7.63	+2.3	7.45	7.46	+0.3	7.63†	7.63	0
t. clay tile, 3x12x12	81.30	86.33	+6.0	81.00	81.30	+0.4	85 07	86.33	+2.0
g asphalt, cars, ton	15.43	15.48	+0.5	15.40	15.43	+0.2	15.48	15.48	0

† *Revised*

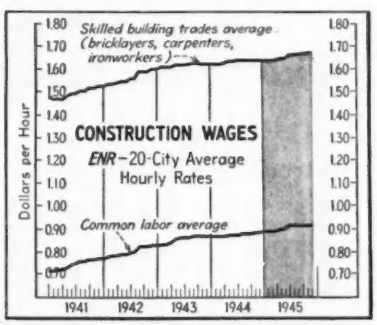
ENR INDEX NUMBERS

Base = 100	Construction Cost 1913	Construction Cost 1926	Building Cost 1913	Building Cost 1926	Volume '13	Volume '26
Nov., 1945	309.28	148 67	240.55	130.00	...	...
Oct., 1945	309.28	148.67	240.35	129.93	167	73
Sept., 1945	309.28	148.67	240.07	129.77	164	72
Aug., 1945	309.08	148.57	239.94	129.70	119	52
July, 1945	308 99	148.53	239.64	129 54	119	52
June, 1945	308 99	148.53	239.37	129.40	133	58
May, 1945	307.43	147.78	238.46	128.90	93	41
April, 1945	306.43	147.30	238.46	128 90	99	43
Mar., 1945	304 50	146.37	237.85	128.57	103	45
Feb., 1945	303 70	145.99	237.71	128.50	78	34
Jan., 1945	302.50	145.41	236.51	127.85	63	28
Dec., 1944	302.30	145.32	236.51	127.85	66	29
Nov., 1944	301.09	144.73	236.10	127.63	74	33
Oct., 1944	301.06	144.72	236.00	127.57	91	40
1944 (Av.)	298.64	143.59	234.73	126.89	96	42
1943 (Av.)	289.95	139.38	228.75	123.66	176	77
1942 (Av.)	276.31	132.82	222.39	120.22	553	243
1941 (Av.)	257.84	123 95	211.46	114.32	375	164

MATERIAL SHIPMENTS . . . . BUILDING PERMITS

	October 1944	October 1945	% Change	Sept. 1945	% Change Sept.-Oct.
(% operating capacity) A. I. S. I.	96.4	71 2	−26	80.5	−12

	September 1944	September 1945	% Change	Nine Months 1944	Nine Months 1945	% Change
icated Structural Steel, tons, A.I.S.C.	57,541	53,686	−7	415,672	515,479	+24
ent, thous. bbl. U. S. B. of M	10,121	11,210	+11	71,996	76,652	+6.5
ding Permits, 215 cities, Dun & Brad-reet's (,000 omitted)	$70,385	$121,266	+72.3	$574,113	$728,562	+26.9



ST OF LIVING INDEX . . . CIVIL NON-AGRICULTURAL EMPLOYMENT

	September 1944	September 1945	% Change	August 1945	% Change Aug.-Sept.
of Living Index, N. I. C. B.	105 0	106.2	+1.0	106.6	−0.3
(Housing) Index, N. I. C. B.	90.9	91.0	+0.1	91.0	0
l Employment (est.) thous., B. L. S.	38,571	35,268	−10	36,894	−4
tr. Employment (est.) thous., B. L. S.	571	946	+41	951	−0.4

ENGINEERING CONSTRUCTION CONTRACTS — ENGINEERING NEWS-RECORD — OCTOBER, 1945

ineering News-Record *reports continental U. S. Construction projects of the following minimum costs—waterworks, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Mid West	West of Mississippi	Far West	United States October 1945	United States Ten Months 1945	United States Ten Months 1944	Canada
ic Works										
Waterworks	976	1,254	63	516	815	1,367	4,991	45,335	27,624	349
Sewerage	216	760	1,324	794	487	539	4,120	28,333	27,038	279
Bridges, public	794	4,462	720	326	865	373	7,540	29,622	12,408	129
Earthwork and waterways	1,484	28	593	1,186	2,541	1,090	6,922	45,223	59,131	870
Streets and roads	1,570	3,039	1,104	3,525	5,982	2,985	18,205	187,009	173,359	4,110
Buildings, public	146	6,504	1,533	2,446	2,987	909	14,525	428,073	567,430	320
Unclassified, public	114	1,604	533	1,068	1,024	607	4,950	232,148	325,917	75
l public	**5,300**	**17,651**	**5,870**	**9,861**	**14,701**	**7,870**	**61,253**	**995,743**	**1,192,907**	**6,132**
Federal government (included in above classifications)	1,301	6,895	1,873	1,491	4,642	2,357	18,559	694,467	978,480	.....
ate										
Bridges, private	.....	.....	.....	.....	175	.....	175	3,981	1,460	.....
Industrial buildings	2,826	7,751	2,682	35,862	14,229	12,202	75,552	437,649	148,680	2,073
Commercial buildings	950	26,700	1,816	11,862	5,933	28,241	75,502	205,062	120,687	2,516
Unclassified, private	226	.....	1,202	725	19,246	5,555	26,954	93,255	43,022	1,415
l private	**4,002**	**34,451**	**5,700**	**48,449**	**39,583**	**45,998**	**178,183**	**739,947**	**313,849**	**6,004**
l Engineering Construction:										
October 1945 — 4 weeks	**9,302**	**52,102**	**11,570**	**58,310**	**54,284**	**53,868**	**239,436**	.....	.....	**12,136**
ember 1945 — 5 weeks	6,801	71,197	22,225	70,048	35,525	29,359	235,135	.....	.....	18,226
ber 1944 — 4 weeks	5,812	14,939	13,293	10,458	50,889	31,804	127,195	.....	.....	19,690
months — 1945	**74,803**	**305,737**	**248,441**	**326,366**	**368,785**	**411,558**	.....	**1,735,690**	.....	**129,158**
months — 1944	44,763	222,623	248,484	183,202	288,572	519,112	.....	.....	**1,506,756**	99,668

WHEN HEADLAMPS PROVIDE THE ONLY ILLUMINATION...

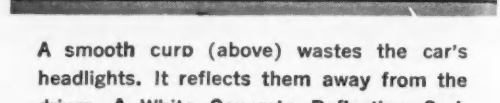
drivers can depend on *White Concrete Reflecting Curb* made with Atlas White Cement

This scientifically designed curb greatly increases the value of car headlamps. The projecting saw-tooth faces of the curb catch the lamp rays and reflect them back to the driver. They create a bright ribbon of reflected light that clearly defines the edge of the road.

White Concrete reflecting curb made with Atlas White cement may be built into any road . . . old or new.

Write for details. Send for booklet.

A smooth curb (above) wastes the car's headlights. It reflects them away from the driver. A White Concrete Reflecting Curb (below) conserves this light. It reflects the headlights back to the driver. Thus a smooth curb is barely visible at night, while a White Concrete Reflecting Curb stands out—bright and clear. Write for details.



ENR-RM-43

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(United States Steel Corporation Subsidiary)

Chrysler Building New York 17, N. Y.

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SUNDAY EVENINGS—American Broadcasting Company (Blue) Network—U. S. Steel's "The Theatre Guild on the Air"

The Week In Engineering and Construction

GINEERING NEWS-RECORD • NOVEMBER 1, 1945 • VOLUME 135 • NUMBER 18

"No labor trouble" clause balks bids on New York low-cost housing job

ualified bidders refuse tenders in protest—Housing Authority lls conference to consider modification—Metropolitan Life Co., eanwhile, lets $32,000,000 contracts for three housing jobs

lking at a contract clause requir- voidance of labor troubles, thirteen pective bidders last week refused to it bids on the New York City sing Authority's Elliott houses— duled to be the first of 13 low-cost ects built by the authority.

ost of the project was estimated at t $3,860,000.

lmond D. Butler, chairman of the ority, said eight of the contractors' esentatives, attending a session Oct. t which bids were to be opened, him that clause 32A in the con- t, entitled "Avoidance of Labor ubles", was the sole consideration t had kept them from offering bids. Mr. Butler said that a similar provi- is included in every city contract. The questioned clause says: "The tractor shall not have material pro- ed or obtained, nor shall he have k performed or labor or means em- yed in the carrying out of this con- t that would in any way cause or lt in a suspension, or a delay of, strike upon the work to be performed eunder, or any of the trades working or about any of the buildings of the hority, or working upon any build- of the authority or working upon of the premises of the authority. violation by the contractor of this uirement may, upon certification of director, be considered a proper sufficient cause for declaring the tractor to be in default, and for the hority to take action against him as forth in the contract."

Pending the outcome of conferences ed by the Housing Authority to con- r possible modification of class 32A, date for opening the bids, was an- nced "tentatively postponed" until ember 7.

The John Lovejoy Elliott Houses, ned to house 617 families, will be ted in an area bounded by 25th and h streets, between Ninth and Tenth nues. Ground has been cleared for the project and the site is ready for new work. Construction of the project, which will include four 11 and 12-story apartments had been postponed by war-time material shortages.

Metropolitan Life lets work

The Metropolitan Life Insurance Co. last week awarded bids totalling $32,123,764 for construction of three major housing projects in the Borough of Manhattan, New York City.

First large-scale housing development to be let by private interests since the end of the war, the three jobs are: Stuyvesant Town, a 67-acre site bounded by First Ave., 14th street, the East River Drive and 20th St., comprising 35 ten to thirteen-story apartment buildings, and six one-story garages; Riverton Houses, on a site bounded by 135th St., 138th St., the Harlem River Drive and Fifth Ave., comprising seven 13-story apartment buildings; and Peter Cooper Village, bounded by 20th St., First Ave. and the East River, where six 15-story apartments will be built.

Contracts on all three jobs were awarded to Starrett Bros. and Eken, New York City.

Close inventory control is placed on lumber

On Oct. 28 lumber was placed under inventory control by the War Production Board in a move to prevent hoarding and to speed expansion of the construction industry.

The inventory limitations apply to all users of lumber for production, maintenance, repair or for construction.

Specific inventory limitations now apply to the following building materials: Lumber, steel, cast iron soil pipe, and copper wire and brass mill products. Receipts of all other building materials are limited by the revised priorities regulation No. 32 to practicable minimum working inventory levels.

State Highway Officials pick Oklahoma City

Oklahoma City has been chosen by the American Association of State Highway Officials for its annual convention next Jan. 29 through Feb. 1, according to Hal H. Hale, executive secretary. This meeting will take the place of the regular 1945 annual meeting which ordinarily would have been held some time this month, and will have no bearing on the 1946 convention to be held some time in the fall of next year.

Plans are also under way for the annual meeting of the Highway Research Board to be held in Oklahoma City on Jan. 25-28, just prior to the A.A.S.H.O. meeting.

Preliminary plans for the A.A.S.H.O. convention were drafted last week in Chicago at an executive committee meeting of the association. Attendance is expected to exceed pre-war registration. Most of the sessions will be focused on the many vital problems connected with implementing and prosecuting the huge highway construction program authorized by the National Highway Act of 1944.

In addition to routine administrative business, the executive committee of the A.A.S.H.O. adopted a proposal to join forces, at the national level, with the American Association of Motor Vehicle Administrators and the International Association of Chiefs of Police, in the interest of promoting safe and efficient highway transportation measures nationally.

Herman A. McDonald, Massachusetts, president of the association, appointed the following highway officials to serve on the program committee for the convention: D. C. Greer, Texas, chairman; Ben T. Childers, Oklahoma; Carl W. Brown, Missouri; R. C. Keeling, Kansas; also H. S. Fairbanks of the Public Roads Administration, Washington, D. C. and Mr. Hale.

Will add stiffeners to Whitestone Bridge

Bids for stiffening trusses, painting and widening roadway on structure are 10 percent over 1942 figures.

Woodcrest Construction Co. of New York on Oct. 23 submitted a low bid of $1,312,000 for widening the roadways, stiffening the trusses to reduce movement, and painting of the Bronx-Whitestone Bridge over the East River in New York City.

In March, 1942, a single bid of $1,060,000 was received for similar work—exclusive of the painting—so present prices are estimated to be about 10 percent above what it would have cost then. Construction was not undertaken at that time as the city was negotiating for a lower price, and priorities assigned to the project were found not to be high enough to secure material.

The principal part of the new work is adding stiffening trusses, which will consist of a top chord 14 ft. above the existing 11-ft. deep girders. A vertical member of the truss will be installed at each cable hanger point, 39.5 ft. c. to c. and at a point midway between the hangers. A single diagonal member slopes each way from the top chord of the truss at the hanger to the central vertical. The present stiffening girder will serve as the bottom chord of the truss.

Sidewalks on the bridge will be eliminated and the roadway widened from 27.5 to 30.8 ft. to accommodate safely three lanes of traffic in each direction. The revised roadway will retain the 4-ft. center mall. The new width will be attained on the suspended span by moving the barrier curb out into the present sidewalk area. On the steel approach spans this same procedure can be used on one side but on the opposite side, where there is now no sidewalk, it will be necessary to extend the existing cantilever brackets. The concrete approach ramp will be widened by using the sidewalk area where it exists or by adding a new section.

Whitestone Bridge already has a single set of inclined cable ties added from the top of the tower to the roadway, diagonal ties at the center to the cables and a damping system installed at each end of the 2,300-ft. main span at the tower. These installations have appreciably reduced the movement of the bridge. Low velocity winds have little effect on the bridge but velocities of 35 to 40 mph. have caused movement of 2 ft.

These changes were proposed by O. H. Ammann, who designed the bridge for the Triborough Bridge Authority. Madigan-Hyland will be in charge of the new work.

Two states earmark works funds

The public works programs of two states—Ohio and Arkansas—are typ of what is taking place throughout the country as postwar buildin proj pass from planning to construction stages.

Funds for Ohio's postwar building program, totaling $79,834,948, became available Oct. 18, subject to the release by the State Board of Control. An "avalanche" of requests for the various departments and institutions is expected, despite a warning by Gov. Frank J. Lausche that only emergency construction should be launched while current high material prices prevail.

Largest construction program to be undertaken is that of the State Welfare department, which was allotted $34 million of the total available for expansion of facilities at various state institutions. Herman P. Geiser has been named supervisor of the department's program.

The Welfare Department has set aside $10 million for new buildings, sites for which have yet to be selected—one committee is still looking for a site for a new $5,000,000 penitentiary, and another is studying the site for two wings to be added to the state office building at Columbus, at a cost of $5 million.

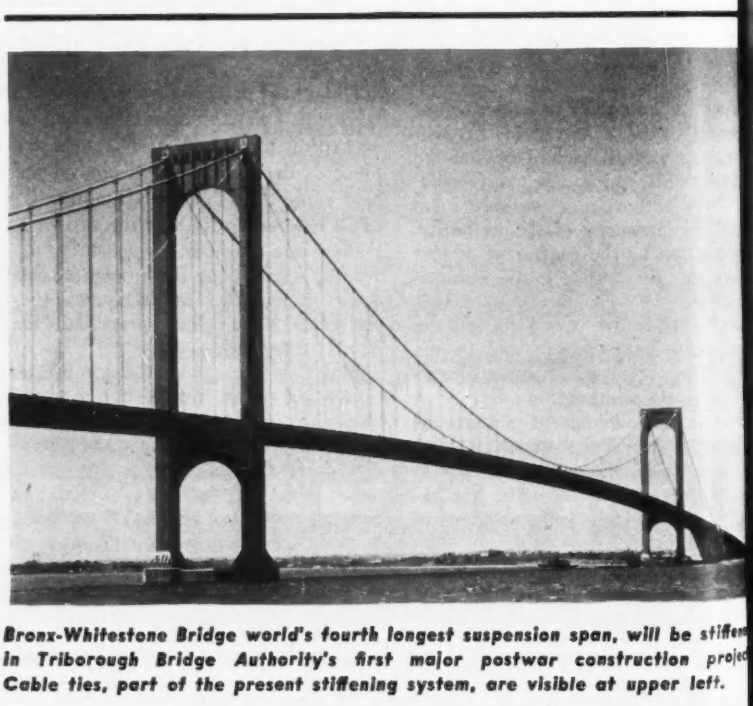
Meanwhile, Ohio State University officials will ask for early release of $5,000,000 for the new health center and dental clinic to be built near the University Hospital, Columbus. In addition, there has been ear-marked another $3,913,000 for new buildings at Ohio State, as follows: Power plant remodeling, $90,400; agricultural laboratories, $600,000; physics building, $650,000; recitation building, $525,0 central service building, $650,000; dustrial x-ray laboratories, $180,0 dairy herd barns, $50,000; botany zoology addition, $374,483; power p equipment, $706,250; electrical d bution equipment, $87,790.

Ohio State is one of six state ported universities which also will release of $2,700,000 for dormitories.

Arkansas plans

W. H. Sindt, acting division engi of the Bureau of Community Facili W. B. Marack, bureau district engi and T. H. Alford, director of the P ning Division of the Arkansas Resou and Development Commission, make a survey of postwar public wo as planned by the state, counties, m cipalities and schools. They will p pare a list of the projects and estim the cost of each.

The $12,674,000 appropriated by 1945 legislature has been allocated follows: $6,000,000 for matching fede highway funds; $5,000,000 for the s highway fund; $500,000 for the U versity of Arkansas building fun $429,000 for the McRae Sanitori $350,000 for the State hospital; $2 000 for the capitol heating plant basement repairs; $120,000 for the st School for the Deaf; and $25,000 fo Negro girls training school.



Bronx-Whitestone Bridge world's fourth longest suspension span, will be stiffen in Triborough Bridge Authority's first major postwar construction proje Cable ties, part of the present stiffening system, are visible at upper left.

New England flood control group to aid Connecticut River development

States will cooperate on educational, engineering details—Protest formation of regional valley authorities

The governors of five New England states last week approved formation of an Inter-State Flood Control Committee that will cooperate with federal authorities to aid completion of a $92,000,000 flood control program for the Connecticut River Valley.

The move by the states is probably the first concerted action of its kind, looking towards some measure of control by the states over large-scale flood control operations within their borders.

A primary purpose will be educational, in that the committee will attempt to explain needs for the proposed projects to the people directly affected, said Gov. Raymond E. Baldwin, of Connecticut. "Bitter" opposition to proposals to construct dams in New Hampshire and Vermont to protect Connecticut lands from floods has been expressed in past years, it was noted.

Additionally, the organization will work with the Corps of Engineers on engineering and legislative problems involved in the projects, which overlap the boundaries of several of the states.

Attending the meeting at Hartford, Conn., on the invitation of Gov. Maurice J. Tobin of Massachusetts, were the chief executives of Connecticut, New Hampshire, Vermont and Rhode Island. Gov. Horace A. Hildreth of Maine was unable to attend.

The governors received a comprehensive report on flood control, navigation and hydro-electric developments existing and planned for the Connecticut, Thames and Hoosatonic Rivers. It also heard Brig. Gen. J. A. O'Connor, New England division engineer who said that $29,000,000 has already been spent on the projected control of the Connecticut. Federal funds will soon be available to complete the $92,000,000 project.

Vermont's Attorney-General Alvin J. Parker urged formation of the joint flood control committee as a means to "head off" federally-regulated regional valley authorities of the type of the Tennessee Valley Authority.

"Flood control here has been dominated by Washington in accordance with the 1938 Flood Control Act," Mr. Parker said. "New England states must assume their responsibilities to their people and carry them out.

"Upstream states, too, must realize their responsibilities to the states below. Dams and other works must be built on some streams in upstream states to protect other communities downstream."

The governors viewed motion pictures presented by the Army showing the disastrous Connecticut River floods of 1936 and 1938, and were told that Army plans provide an estimated 140 percent protection over the control measures in existence in those years.

J. P. H. Perry new head of Engineering Trustees

United Engineering Trustees, Inc., last week elected J. P. H. Perry, vice-president of the Turner Construction Co. as president.

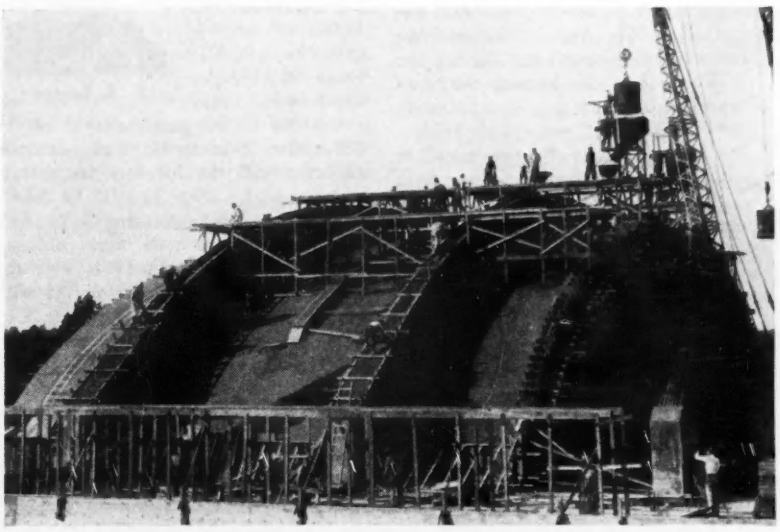
The organization is titular owner of the Engineering Societies Building, and through the Engineering Foundation and the Engineering Societies Library, its purpose is to promote the advancement of the engineering arts and sciences.

Proposed charter asks engineering experience

Seattle, Wash., will vote next March on a proposed new city charter that strengthens required qualifications for city engineer and city building superintendent.

The proposed new charter stipulates that the city engineer shall have "actually engaged in the practice of his profession for 10 years immediately prior to his appointment; shall be licensed to practice his profession in the state; shall be a civil engineer of high professional and ethical standing, and shall be qualified not only to direct but also to conceive and design engineering work." It also requires that the building superintendent shall be a "structural engineer or architect who shall have been actively engaged in the practice of his profession for five years prior to his appointment or a skilled building craftsman who has had not less than five years' experience in a responsible supervisory capacity on the designing, construction or maintenance of buildings."

The new charter also would extend to four years the terms of office of the mayor and members of the Board of Public Works.



Ribbed shell hangar to house test laboratory

Under construction for General Electric Co. at the Schenectady, N. Y., County Airport is this $500,000 reinforced concrete flight test laboratory. Large enough to house four B-24 bombers, it will have a clear width of 160 ft., length of 175 ft. and a height at center of 45 ft.

Two floors of laboratories, work rooms and offices will be provided on one side.

The shell of the hangar varies in thickness from 3½ in. at the crown to 7½ in. at the outer edges. Spaced 34 ft. 6 in. on centers, the ribs, which protrude from the shell on the exterior, are 6 ft. 9 in. deep at the crown and vary in width from 2 ft. to 3 ft. 2 in. Last of three sections was cast this week.

Marcus T. Reynolds, Albany, N. Y., is the architect and Roberts & Schaefer, Chicago, Ill., are the structural designers. Contractor is Corbetta Construction Co., New York, N. Y., for whom Fred Foss is project manager and Fred W. Narr superintendent.

E. B. Whitman retires as Maryland roads chief

Ezra B. Whitman, chairman of the Maryland State Roads Commission since 1939, retired from that post last week. He is succeeded by Robert M. Reindollar, formerly assistant chief engineer for the commission.

Mr. Whitman, 66, notified Governor Herbert R. O'Conor some months ago of his desire to retire—a move dictated by his physician. However Mr. Whitman remained at his post until the present time to oversee planning for what the governor termed "the greatest program of road building" in the state's history.

E. B. Whitman

Mr. Whitman will continue his association with the firm of Whitman, Requardt and Associates, which he has headed since 1915.

An engineering graduate of Cornell University, Mr. Whitman spent five years as a member of a New York consulting firm before returning to his native Baltimore in 1906 to supervise the design and construction of municipal sewage disposal plants. In 1911, he served as chief engineer of the Baltimore water department; was a major in the Army's Constructing Quartermaster Department during the first World War. He became chairman of the Public Service Commission in 1921, holding that post until 1927.

Mr. Reindollar, a "career man" in road building operations, has been with the State Roads Commission for 33 years. He was assistant chief engineer for the past 16 years. He will fill out the remaining 5½ years of Mr. Whitman's term.

Boston will build bridge over Chelsea River

Construction of a $1,800,000 bridge over the Chelsea River at Meridian Street between Boston and East Boston, Mass., will start before the spring of 1946, according to John DeMenlenaer, division engineer, Department of Bridges for the city of Boston. Plans are now being completed by Charles A. Maguire & Associates of Providence, R. I.

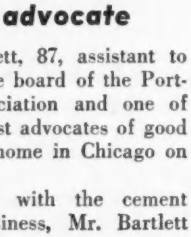
The new bridge, which will replace a swing structure built in 1911, will be a double-leaf, rolling lift bascule, providing a 175-ft. clear channel.

Plans call for the construction of ten granite-faced concrete piers and two abutments, all supported on wood piles. Three steel deck girders of about 90 ft. span, five of 84 ft. span and two of 40 ft. span with 225 ft. for the full length of the bascule, give a total length of bridge of about 1,000 ft. The roadway will be 40 ft. wide from curb to curb, flanked by a 10 ft. wide sidewalk on each side. The approach spans will be provided with a reinforced concrete deck with granite block pavement and the movable span will have an open steel deck.

George S. Bartlett dies, good roads advocate

George S. Bartlett, 87, assistant to the chairman of the board of the Portland Cement Association and one of the nation's foremost advocates of good roads, died at his home in Chicago on Oct. 21.

Long associated with the cement manufacturing business, Mr. Bartlett was one of the prime movers in the promotion of the use of hard-surfaced pavement on the nation's highways.



G. S. Bartlett

Born in New York City April 2, 1858, he was a graduate of Williston College, Easthampton, Mass.

In 1884 he became manager of the Milwaukee Cement Co. and remained affiliated with the industry for the remainder of his life. In 1912 he joined the Universal Atlas Cement Co. at Chicago, and served with that company until his retirement in 1931, with the exception of a three year period with the Edison Portland Cement Co., Orange, N. J.

Working with the late Edward N. Hines, chairman of the Wayne County, Mich., Board of Road Commissioners, which had put down experimental stretches of concrete paving in 1909, and with the late Benjamin F. Affleck, then general sales agent of the Universal Portland Cement Co., Mr. Bartlett was instrumental in bringing many parties of city, state and county road and street officials to Detroit to view the new pavement.

The George S. Bartlett Award, sponsored by the American Association of State Highway Officials, the American Road Builders Association and the Highway Research Board of the National Research Council, awarded annually for outstanding contributions to highway progress, is named in his honor.

NEWS IN BRIEF

In telegraphic form, here are further news developments on the engineering and construction front during the week.

Private Construction—The Monsanto Chemical Co. plans a $1,500,000 plant for manufacture of synthetic caffeine in ST. LOUIS, Mo. . . . Freuhauf Trailer Co. will build $3,500,000 worth of manufacturing and service plants in LOS ANGELES, SAN DIEGO and FRESNO, Cal. . . . A $5,750,000 project that will include two new warehouses, a new pier and a 280-car supporting yard will be built at NORFOLK, Va., by the Norfolk & Western Ry. Co. . . . The Gypsum Corp. of America is ready to start work on a $1,689,290 pier in downtown BALTIMORE, Md. . . . The Ford Motor Co. let a contract for "about $1,000,000" to the Virginia Engineering Co. for expansion of the motor plant at MEMPHIS, Tenn.

Highways—MASSACHUSETTS will advertise for bids before the end of the year on $2,925,000 for seven state highway jobs. . . . LOUISIANA highway officials said they planned a $31,000,000 highway program for the fiscal year ending June 30, 1946. . . . The NEW YORK State Public Service Commission approved a $4,000,000 railroad track relocation program at Rochester. . . . WISCONSIN planned expenditure of $54,700,000 on its state trunk highway system. . . . ARIZONA approved a law making the State Highway Commission secretary an appointee of the governor, and raising salary in the post to $7,200 yearly. . . . KANSAS planned to spend more than $20,000,000 on 1,337 miles of primary highways. . . . MISSOURI will be ready to make its first highway bid-awards for some $1,000,000 of work, by mid-November.

Miscellany—Heirs of 56 employees of the East Ohio Gas Co. killed in an explosion and fire at the company's CLEVELAND plant (*ENR* Aug. 30, vol. p. 268) have filed damage suits aggregating more than $5,000,000 against the Pittsburgh-Des Moines Steel Co. and others, charging negligence in designing steel storage tanks. . . . CANADA this week received bids in its first sale of surplus war construction equipment.

Refuse disposal—The ILLINOIS Department of Public Works and Buildings said it would take immediate steps to stop dumping of refuse into the abandoned Illinois and Michigan Canal.

ENGINEERING SCHOOL NEWS

New courses at Michigan CMT—Construction at The Citadel—Many veterans enter Carnegie—Guidance center for Stevens

New courses in aerial surveying, airport engineering, and hydrology are among the changes instituted by Prof. Wilfrid C. Polkinghorne, newly appointed head of the civil engineering department of the Michigan College of Mining and Technology, Houghton, Mich. His revision of the departmental curriculum will also lead to a more clearcut separation among the various options—hydraulic, sanitary, structural, and transportation engineering.

Prof. Polkinghorne holds the degrees of bachelor of science and engineer of mines from MCMT, and master of science from Yale. After several years as draftsman, engineer, and then assistant superintendent with a Michigan mining company, he joined the faculty of his alma mater. On being made department head this fall, he became full professor.

A $1,140,000 campaign to insure early expansion is under way at Clarkson College of Technology at Potsdam, N. Y. Included in addition to the acquisition of the Potsdam State Teachers College property, will be the construction of a large gymnasium with a War Memorial bell tower, the purchase of additional property adjacent to the campus and the conversion of the present gymnasium into a completely equipped chemical laboratory.

A $2,391,000 construction program for The Citadel, Charleston, S. C., heads new project requests for federal aid received by the South Carolina State Research, Planning and Development Board. Included in the projects covered by the Citadel request is $175,000 for an engineering laboratory building.

The influx of veterans at Carnegie Tech has been so great this term that the College of Engineering and Science has more applications than it can take care of. There are 319 veterans on the campus now, it was revealed. The majority, 561, are enrolled in the College of Engineering and Science.

The establishment of a Veterans Administration guidance center at Stevens Institute of Technology is announced. Capt. Elmer Klinsman is chief of the center for the veterans administration and the advisory group for Stevens Institute is directed by Dr. Frederick J. Gaudet, associate psychology professor.

The center will be equipped to serve up to 150 veterans per week.

Private water rights acquired by Paterson

The SUM, chartered in 1791, finally sells water power rights ending tax exemption controversy

A long chapter in the history of water power for industrial purposes, in the water supply of cities and in the change from private to municipal ownership of both has been closed. On Oct. 23 the Society for Establishing Useful Manufactures, (SUM) deeded its rights in the Great Falls of the Passaic River, together with its power plants, to the City of Paterson, N. J. The city paid $450,000 for the properties.

Chartered by the State of New Jersey in 1791, the society was founded by Alexander Hamilton and others. (See "A Regional Development Project of Pioneer Days," *ENR*, Jan. 10, 1935, p. 45). Most notable of the early incorporated companies it employed Charles Pierre L'Enfant, planner of the national capital, as engineer, to develop the power of the 90-ft. falls of the Passaic River.

As owner of the water-power rights on the lower Passaic, including ultimately those at Passaic below and at Little Falls above Paterson, the SUM was in a master position as regards water power in the drainage area of the Passaic River. The Lehigh Valley Railroad Co., through purchase of the Morris & Essex Canal, had similar control of water for navigation.

By a junction of the interests of these companies, acquisition of the water companies supplying Paterson and Passaic, formation of the Montclair Water Co. and several pyramiding companies, a monopoly on the water resources of a large part of northeastern New Jersey was obtained.

For some years the municipalities concerned, acting alone or in water districts, have acquired these supply works. Paterson's action ends the exemption from taxation granted to SUM by its charter of 1791, which the city has contested unsuccessfully for nearly a century.—*M. N. Baker.*

Connecticut town funds available for state work

Assistant Attorney General Arthur F. Brown of Connecticut has ruled that the State Highway Department may borrow from cash balances in the highway fund for immediate use. (*ENR* Oct. 4, vol. p. 414). These funds are in town aid and state aid accounts and represent allocations to specific towns under various state acts, but not appropriated by the legislature.

William J. Cox, highway commissioner, declared the ruling will enable the state to match federal funds on urgent road projects. With funds allotted by the State Finance Advisory Committee, the State Highway Department will embark at once on a program of $8,000,000 worth of road and bridge construction at the rate of $1,000,000 per month.

Initial projects include large grading and drainage jobs in connections with the Wilbur Cross Parkway, and rigid frame reinforced concrete highway bridges in Meriden and Wallingford.

D. C. slum clearance bill is passed by Senate

A bill (S. 1426) providing $20,000,000 for a 10-year program of slum clearance and rehabilitation in the District of Columbia has been passed by the Senate. The measure is expected to encourage both private and public housing groups in the elimination of the extensive blighted areas in Washington.

A 5-man District of Columbia Redevelopment Land Agency, with two members appointed by the President and three by the District Commissioners is created by the bill. This agency would have broad powers to further the elimination of areas of substandard housing. The agency would work closely with the National Capital Park and Planning Commission in obtaining necessary land for housing developments, in determining the best housing plan for the District of Columbia, and in assisting private and public housing groups in using the acquired land. The $20,000,000 of federal money would be used as a special trust fund.

Correction

A contract for $2,487,590 has been awarded to the Dravo Corp., Pittsburgh, Pa., for construction of the South Capitol St. Bridge in Washington, D. C. In its issue of Oct. 18, *ENR* erroneously reported that the Job had been awarded to Spencer, White and Prentis, of New York City.

OBITUARY

Lt. Col. Howard G. Sheldon, 56, graduate of Syracuse University and construction engineer with the U. S. Army Engineers, was killed Oct. 21 in an Army plane crash in Alaska. Colonel Sheldon, who lived in Washington, D. C., before the war, had been stationed in Alaska and the Aleutians for the last two years and was on his way home when the accident occurred. Colonel Sheldon had served in France in the first world war. When World War II began he was working with the Reconstruction Finance Corporation.

Henry Borriello, 56, civil engineer for the last ten years with the Federal Public Housing Authority, died in Washington Oct. 20. Born in Italy, Mr. Borriello came to the United States in 1899. He was graduated from Cooper Union as a civil engineer. At the time of his death he was construction cost analyist for the FPHA.

William B. Weldon, assistant engineer in charge of planning, Water Pipe Extension Division, Department of Public Works, Chicago, died recently. He had been an employee of Chicago for 40 years, having started with the Board of Local Improvements in 1905.

Elmer E. Wood, 80, who operated the first Modesto, Calif., water works and electric plant and served as city engineer in 1895, died in Modesto Oct. 15.

Ralph E. Bell, 52, of Cleveland, Ohio, a construction engineer, died Oct. 19. As superintendent of construction for the Lundorff-Bicknell Co., Mr. Bell had charge of the erection of a number of large buildings in Cleveland, including the Union Commerce Building, Severance Hall, St. Luke's Hospital and several units of St. Alexis' Hospital. He was graduated from Westminster College, New Wilmington, Pa., as a civil engineer, and served in World War I.

William P. Roberts, 56, consulting engineer and superintendent of building construction, died at his home in New York City Oct. 23. A graduate of the College of the City of New York and of the Institute of Mechanics and Arts, for 22 years he was with the firm of Marc Eidlitz and Son. He participated in the building of these well-known New York structures: Columbia-Presbyterian Medical Center, the Columbia University Library, Western Union Telegraph building, New York Cornell Medical Center.

Engineers will collect Upper Missouri data

A 1,100-mi. Missouri River reconnaisance, extending from Fort Peck, Mont., to Sioux City, Iowa, to gather engineering data for proposed upstream development projects is now under way. Maj. George Evans, district engineer at Omaha, said that a party of six, accompanied by two engineers from the Fort Peck district, will study erosion and channel development.

A month's trip is being made to investigate the feasibility of river development suggestions made during recent hearings at Niobrara, Neb., and Pierre, S. D. Final data will be submitted to the district engineer, and to the engineering projects board of review in Washington. Extension of navigation upstream above Sioux City and bank erosion protection will be the primary objective of the survey.

Orlando A. Welch of Omaha, in charge of the engineering party, said that aerial reconnaissance photographs taken recently will be used to determine erosion conditions.

Nisqually delivers power

The $23,000,000 Second Nisqually Power Project at Tacoma, Wash., started producing electricity recently.

Tests of the new generator in the enlarged La Grande power plant were completed late in September, and two of the four original units there were put into operation. Tests were delayed five months by a break in the lining of the 14½ ft., mile-long tunnel through the power house last April. This break, caused by shifting of the overburden, necessitated installation of additional steel linings.

The project involves construction of two dams in addition to the tunnel.

Singleton leaves Army for private practice

Lt. Col. Jack Singleton, chief of the bridge branch, Office of the Chief of Engineers, Oct. 28 was released from active duty. He has been named chief engineer of the American Institute of Steel Construction, in New York. In World War I Col. Singleton was commissioned first lieutenant, Corps of Engineers, and served overseas with the AEF.

Col. Singleton again volunteered for service in the Engineers on the day after Pearl Harbor. He was made area engineer at Kansas City, Mo., constructing the North American Aviation Plant. Later, after graduation from the Command and General staff school, he served for a year as executive officer for the U. S. Engineers at the desert training center.

In civilian life, Col. Singleton was consulting engineer on designs of bridges and buildings for 25 years.

JOBS OF THE WEEK

STEEL PLANT, Vernon, Calif.

Bethlehem Steel Co., Vernon, Calif., and Bethlehem, Pa., will construct, by its own forces a steel plant, including hearth furnace mills for rod, bar and wire finishing, to cost from about $7,000,000 to $8,000,000.

CONCRETE PIPE LINE, San Diego, Calif.

Bureau of Yards & Docks, Navy Department, Arlington, Va., awarded a contract for a concrete pipe line and structures on San Diego Aqueduct, Riverside and San Diego Counties, to United Concrete Pipe Corp., Los Angeles at $3,361,089.

ALTERING ST. LOUIS ORDNANCE PLANT, St. Louis, Mo.

Fruco Construction Co., St. Louis, Mo., has been awarded a contract by U. S. Engineers, St. Louis, for altering and improving the St. Louis Ordnance Plant for use of St. Louis Administration Center, to cost $1,338,236.

HOSPITAL, Charlotte, N. C.

McDevitt & Street Co., Charlotte, N. C., has been awarded a contract by Mercy Hospital, Charlotte, for a 6-story hospital and for remodeling existing buildings at an estimated cost of $1,240,000. Walter W. Hook, Charlotte, N. C. is the architect.

BRIDGE, Terminal Island, Calif.

United Concrete Pipe Corp., Los Angeles, Calif., was the lowest bidder at $5,449,000 for a vertical lift bridge over Cerritos Channel, when Bureau of Yards & Docks, Navy Department, Arlington, Va., opened bids.

Note—Additional bidding and contract news on many projects large and small, including the above items, appear in the Construction News section beginning on page 179.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

rst Engineer General

Sir: The following may be of interest in connection with your statement that General Somervell was not the first engineer officer to reach the full rank of general (*ENR* May 24, p. 736), correcting an error made in the biographical sketch of General Somervell published in the April 26 issue.

Robert E. Lee was probably the first engineer officer to reach the full rank of general. Sent to St. Louis in August, 1837, by General Gratiot, Chief of Engineers, Robert E. Lee, then a lieutenant, was in charge of the work of saving St. Louis as a river port. He was the first engineer officer to use a spur dike on the Mississippi River, which diverted the force of the current from the Illinois shore and eliminated the sand bars which had grounded steamboats attempting to land at the port of St. Louis. By July, 1838, this engineer officer had dashed Duncan's Island downsteam. This deepened the channel and allowed steamboats to land at St. Louis. Following this work, this engineer officer was sent to New York Harbor to handle the engineering works there. He was later made Chief Engineer under General Wool in the war with Mexico.

After a tour of duty as superintendent of the U. S. Military Academy at West Point, he returned to St. Louis in 1855, this time as commander at Jefferson Barracks, adjacent to the city on the south. He was an engineer officer from the time of his graduating at West Point until 1855, when he commanded troops at Jefferson Barracks, Mo., with only short details on other than engineering projects.

A record of what he did at St. Louis, what he reported in a preliminary way, and what he thought he had accomplished when he left St. Louis, is recorded in his personal letters written to Henry S. Kayser, city engineer of St. Louis from the period 1838 to 1846. These personal and original letters, not in his biographies, are in the archives of the Missouri Historical Society in St. Louis, collected by the research of Miss Stella M. Drumm.

ROBERT B. BROOKS
Consulting Engineer,
St. Louis, Mo.

Concrete Column Formulas

Sir: I have read with interest Mr. Boase's articles on reinforced concrete design practice in South America. It is probably true that in Brazil there are numerous buildings with tied columns whose design loads are about 75 percent greater than allowed by the American Concrete Institute code, but it is also true that this is no valid reason for increasing allowable loads on our columns. After all, we know, or at least we hope, that our columns can carry much heavier loads, but our primary interest in what they can carry is in answering the question, "How much should they carry?". I do not believe that the study of foreign codes is going to help us answer this question.

The present A.C.I. tied column formula is a radical departure from previous formulas in that instead of being based on the elastic theory it is a limit formula. It is a result of the work of the A.C.I. Committee 105, who conducted tests at the University of Illinois and at Lehigh University. This committee concluded that the ultimate strength of a tied column is equal to the ultimate strength of the concrete plus the yield point strength of the steel, and that the redistribution of stress under sustained load has no effect on the ultimate strength of a column tested to failure, even though the apparent average increase in steel stress, inferred from strain measurements over a one year period, was 14,000 psi. at Illinois and 22,000 psi. at Lehigh.

Although the committee were all agreed that plastic yielding and shrinkage had no effect on the ultimate strength of the column, the majority recommended, and the A.C.I. adopted with minor changes, a formula which gives the steel relatively more credit and results in a variable factor of safety. This penalizes columns with low steel percentages on the basis that steel stresses are higher when small percentages are used.

The A.C.I. formula, then, makes some allowance for stress redistribution. It looks like the Brazilians have made the same sort of an allowance. Note that, as in formulas used for other structural members, it is not necessary that this formula correctly express the distribution of load between concrete and steel (we do not know it, anyway). Within limits, beyond which the concrete or steel would to the best of our knowledge be excessively penalized, it makes no difference how the formula proportions the load, providing it yields consistent and safe results. However, this does not mean that the difference in thought involved is not important.

If we take the ultimate strength of the concrete in a column as 85 percent of the 6x12-in. cylinder strength, as indicated by the tests of Committee 105, then with a 10x10-in. tied column made with 2500 lb. concrete and 1 percent steel having a yield point of 40,000 psi., the A.C.I. formula infers a factor of safety of 4.3 and the Brazilian formula, 2.4. With the steel percentage changed to 4, the factors of safety are 3.8 and 2.2 respectively. From these figures we can see that the Brazilian column is allowed a load almost 1.8 times that of the A.C.I. column. Likewise, we can see that there is no basic difference in the formulas. We do, however, have a difference of opinion as to what part of the ultimate load can be considered a safe load for the column.

If our formulas are considered too conservative, and they possibly are, then what is needed first is study and interpretation of the data we have. But we must move deliberately. We cannot afford to copy others. These are *our* columns and *our* buildings. We must ask ourselves what we know about columns, and we must assess what we do not know and possibly never will know.

JAMES P. MICHALOS
Assistant Professor of Civil Engineering
Montana State College
Bozeman, Mont.

EDITORIALS

VOLUME 135 NUMBER 18

November 1, 1945

A Premium on Work Stoppages

WHAT LOOKS LIKE the opening gun in a battle between contractors and the City of New York to remove from city contracts an oppressive clause relative to strike responsibilities was fired last week when prequalified firms declined to bid on a New York City Housing Authority project because the contract for the work contains the questioned clause (See p. 71). In effect, this clause states that if action by the contractor in connection with the purchase of materials or employment of labor for the job results in a work stoppage on his job or any other job of the housing authority he may be declared in default on his contract. In this day of work stoppages for the most trivial reason, it is obvious that such a clause, although written into the contract to prevent delays due to labor disputes, puts into the hands of unscrupulous labor leaders a tool that could be used to coerce the contractor into making almost any concession they might see fit to demand. Instead of preventing work stoppages, such a clause would tend to put a premium on them. A far better way to avoid stoppages would appear to be to put faith in an arbitration agreement between responsible unions and contractors such as the one recently drawn up in New York (*ENR* Oct. 4, vol. p. 417), which will go into effect soon if its provisions with respect to wage increases are approved by the Office of Economic Stabilization.

Federal Aid for Research

ENGINEERS would do well to take an interest in the bills authorizing federal aid to research, now being considered by a joint committee of the Senate, because no one of the bills on this subject that are before Congress appears to assure that some of the aid will be used for engineering research. The bills being most actively considered were designed to implement proposals made recently by Vannevar Bush, (*ENR* July 26, vol. p. 86). They can be interpreted as calling for aid for engineering research but they do not specifically say so. Because men like Dr. Bush who were instrumental in having these bills written—and who may have a large say in how the proposed federal aid is used—are men chiefly concerned with pure science, it seems desirable to have the legislation that is finally adopted state specifically that research in engineering problems is to be included. Expansion of research in the basic sciences is highly desirable but if that research is to make its greatest contribution to technological progress, ample funds also must be provided for studies directed toward the practical application of the knowledge acquired by that research.

Stockpiled Construction Equipment

Now that the war emergency is over, and efforts are being directed toward getting the nation back to a peacetime basis, all government agencies including the War and Navy departments, should be subjected to the same inventory controls as apply to private constructors if we are to make the best use of available construction materials. The quantity of such materials that users and suppliers may have on hand is limited to that which will be consumed in the next 60 days. Some construction materials and equipment in the hands of government agencies as a result of overpurchasing or the cancellation of war contracts has been offered for sale, but people who are in a position to know claim that there is very much more that could be released to meet the present serious shortage. Everything so held in excess of that to be used within 60 days should be put on the market. Conservatism, inertia or government red tape should not be permitted to keep these supplies off the market when they are so badly needed as they are today.

What Type of Refuse Disposal?

ONE OF THE FREQUENT QUESTIONS raised by municipal administrators as well as engineers is "What is the best method of refuse disposal?" Like many other apparently simple questions, this one cannot be answered in a simple, straightforward manner. The answer depends on a number of things, not the least of which is the definition of the term "best". Practice considered best in one community—on the basis of efficiency, cost and other less easily defined considerations—may fail to meet the needs of another community of different size, geographic location, terrain and economic complexion. For example, the situation in Atlanta, Ga., is such that incineration coupled with steam production from by-product heat has been adopted; in San Francisco and New York, on the other hand, where large tidal areas lend themselves to land

reclamation, the sanitary fill method is successfully employed. When one studies the variety of practices that characterize municipal refuse disposal, as evidenced in the roundup published elsewhere in this issue, it becomes increasingly apparent that no one system can claim a monopoly on being the best. Each has its virtues and limitations, and selection for a specific situation becomes a matter of critical engineering evaluation.

Unknown Equipment

MANY construction equipment manufacturers apparently think that everyone who buys, uses and operates their machines must know the units and their major characteristics by instinct, for they are content to paint the make name some place on the rig, and to record its model number, size and other important data on a poorly stamped thin metal sheet. At least, that is the practice on the equipment sent to the Army Engineers and the Navy Seabees, according to Harold W. Richardson, of this journal's editorial staff, who writes from out in the Pacific that name and tag both become obliterated with the first repaint job, if the metal tag hasn't already been knocked off or made illegible by mud or splattered concrete. These machines soon become nonentities around the job, and maintenance of the mavericks becomes increasingly difficult as they stray into the hands of strangers.

Unless a manufacturer is ashamed of his product, he should be proud to display his name prominently and permanently thereon. And if he wishes to do his client a real service, in addition to the make name, he should also add the model number, year of make, gross weight and rated capacity in prominent raised and indestructible characters.

This need for full identification has been revealed by war construction operations, especially in forward areas, where many makes and sizes of equipment had to be used indiscriminately by men sometimes not so experienced as they might have been. Furthermore, writes Mr. Richardson, if the manufacturers could only see the utter confusion created by lack of identification of spare parts, they would remedy that situation at once. Many a machine has been deadlined while its needed repair part lay unidentified in a nearby stockpile.

Another equipment need, as revealed by war experience, is the designation of sling or lifting points on each unit. Better yet would be the permanent attachment of lifting lugs or eyes at the proper points. Many a piece of equipment has been damaged and even wrecked because of slings being attached at the wrong places for loading or unloading. Lifting for loading is not a practice restricted to war, either.

While these suggestions come from the former battlefronts, they apply to peacetime construction operations as well. American construction equipment is the finest in the world, but it can be made even better if the manufacturers will pay a little more attention to these details.

War and the Young Engineer

ENGINEERS are trained to work with the forces of nature. One of the well-known definitions of an engineer says that an engineer is one who directs the forces of nature to the use and convenience of man. However, unless an engineer supplements that competence by developing ability to understand and work with those human forces that activate men, his scientific skill seldom attains its fullest potentialities. This latter fact appears to take on a new significance today as we enter the period when thousands of young engineers returning from military service are seeking establishment in some peacetime occupation.

"Book learning" alone never produced a well-rounded engineer. Scholastic training is a great asset, which becomes more valuable as each year goes by, but the able engineer is the product of such scholastic training supplemented by the broader training that comes from having to work for and with other people, from meeting emergencies single-handed, making compromises, and taking defeat standing up.

These considerations lead to the conclusion that the years that many young engineers or potential engineers have spent in military service may turn out to be the most significant part of their engineering training. Military service has many drawbacks, but it is a great builder of self-reliant men and men who know how to work with others. The war has taken many potential engineers, but it may offset this by turning others to engineering and by accelerating the maturity of all who enter the engineering field at the end of their military service.

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EDITORIAL OFFICES: 330 WEST FORTY-SECOND STREET, NEW YORK, N. Y.

France Begins Bridge Reconstruction On Seine and Marne at Paris

Waldo G. Bowman
Editor, Engineering News-Record

***Contents in Brief**—Faced with a stupendous postwar bridge reconstruction job, French engineers and contractors are concentrating their biggest initial effort in the Paris region. No damage occurred to the beautiful and famous bridges in the city itself, but bombs and demolition took their tolls up and down stream, on stream crossings that carry heavy traffic into, out of and around the metropolitan area. Most of the postwar structures here were planned before the war and some were nearly completed during the German occupation. Several are of unique design.*

NONE OF THE TWO DOZEN bridges that cross the Seine River along the eight-mile arc that it inscribes across the city of Paris suffered so much as a scratch of war damage. For that, the world generally and engineers particularly can be more than just casually thankful, since among these structures are some of the most beautiful and historically significant in the world.

Fig. 1. Paris metropolitan region showing location of bridges above and below the city upon which postwar work is scheduled.

Thus, it is still possible to watch heavy modern traffic passing over the stone arches of the Pont Royal, where the Dutch monk, Romain, introduced the cofferdam to pier building in 1685; and to see similar traffic using Perronet's Pont de la Concorde in whose long, flat arches the practice of engineering as a science had its beginnings about the time of the American Revolution. One can like or dislike the heavily ornamented ironwork on the Pont Alexandre III, but it is still possible to see in its long arches of bolted cast steel segments a type of bridge that is unusual, spectacular and inspiring.

And in all of the others, mostly stone arches like the weathered Pont Neuf and Pont Marie, there are lessons of early engineering ability and of centuries of fond care and maintenance that are worth preserving. Even the more recent Pont d'Alma has a claim to posterity, for the giant stone Poilus, who stand on its pier pedestals and wait for the periodic floods to wash over their feet so their picture can be taken and shown in the news-reels, are world famous.

Yet, while French engineers and construction men also share in this feeling of pride and of thankfulness that the bridges of Paris were spared, their satisfaction is tempered by the unparalleled destruction that exists almost everywhere else in the country. Estimates place the number of "cut" bridges in France at 5,000, as compared with 2,000 in 1918. All but four of the 45 bridges over the Seine between Paris and Le Havre are down; destruction is practically as

complete on the 50 crossings of the Loire between Orleans and the sea, and few of the important crossings of the Oise, Marne, Meuse and Moselle have escaped. The necessary task of reconstruction is consequently stupendous, and its contemplation often seems the more appalling since many of the wrecked bridges were rebuilt as recently as 1943, after the French-German fighting of 1940 caused their first destruction.

Reconstruction, nevertheless, is beginning and, somewhat paradoxically, is receiving special emphasis in the Paris region, where, as distinct from the city proper, damage was considerable. In this area many bridge improvements are required, and a sizable postwar construction program is taking shape, under the direction of the Seine Division of the wellknown Services des Ponts et Chaussées, national bridge and road bureau and its chief engineer L.-A. Levy. The nucleus of the program is provided by several projects, planned before the war and in some cases well along in construction or open to traffic, whose completion is desirable at the earliest possible moment.

Three of the bridges—Neuilly, Suresnes and St. Cloud—are just west of the city limits, while three others—Epinay, Argenteuil and Bezons—are slightly farther downstream and to the northwest. Upstream of the city are the remaining structures—at Choisy-le-Roi over the Seine and at Charenton, Bry-sur-Marne and Joinville-le-pont over the Marne. Most of these structures reflect the policy of the Ponts et Chaussées organization to keep alive the French reputation for progressive structural design, and are thus of technical interest aside from their importance as parts of France's postwar reconstruction program.

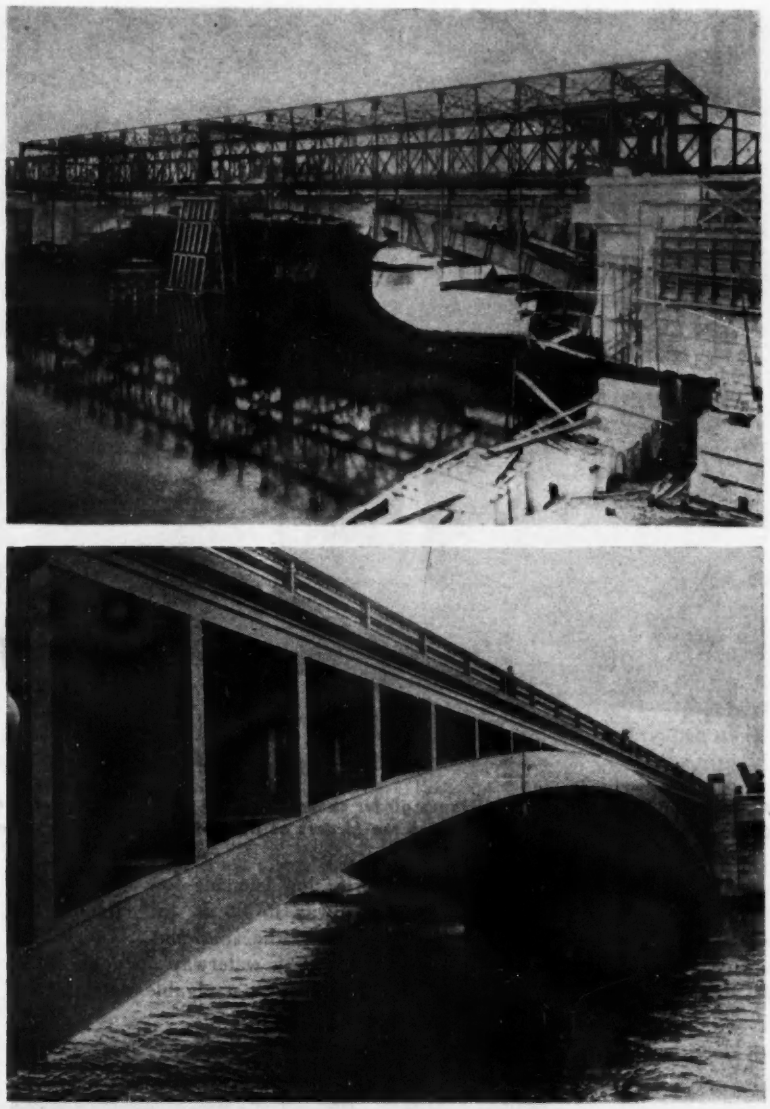


Fig. 2. Welded arch over the Seine at Paris suburb of Neuilly has a span of 269 ft., said to be the longest in the world. Completed (bottom) after the German occupation, it was built with the aid of a truss construction bridge (top) carrying the erection cranes and falsework hangers.

Welded arch of record span

The new bridge over the Seine at Neuilly, at the west city limits of Paris, for example, open to traffic but requiring finishing touches and approach development, contains the longest welded arch in the world and is of further interest as being a replacement for Perronet's famous stone arch bridge built between 1768 and 1780 when he was moving away from the short, massive arches of the Roman type to the slender, flat and long arch spans that he was to introduce in the Pont de la Concorde. The controversy over the removal of this famous and remarkable structure, with stone spans of over 130 ft., was naturally extended and vigorous, but eventually the old bridge had to bow to the necessities of progress in both highway and waterway traffic.

Located on the most important highway leading out of Paris, an extension of the Champs Elysées, the Neuilly bridge consists of two steel arches over two arms of the Seine, which are connected by a concrete arch on an island. Each arch contains 12 two-hinged, welded box-section ribs built up of high strength chrome-copper steel plates. In the longer arch the span is 269 ft., the rise 1/12, and the ribs 2x5 ft. in cross section, while comparable figures for the shorter arch are 219 ft., 1/10, and 2x3.9 ft. The steel, designated as Ac. 54, has an ultimate strength of 54-64 kg/mm² or 77,000-90,000 psi.; its yield point is about 57,000 psi.

The spandrel columns, sway brace members, and the cornice at the roadway level are also box sections of welded steel plates. All these elements are devoid of ornament and severely plain, making a very impres-

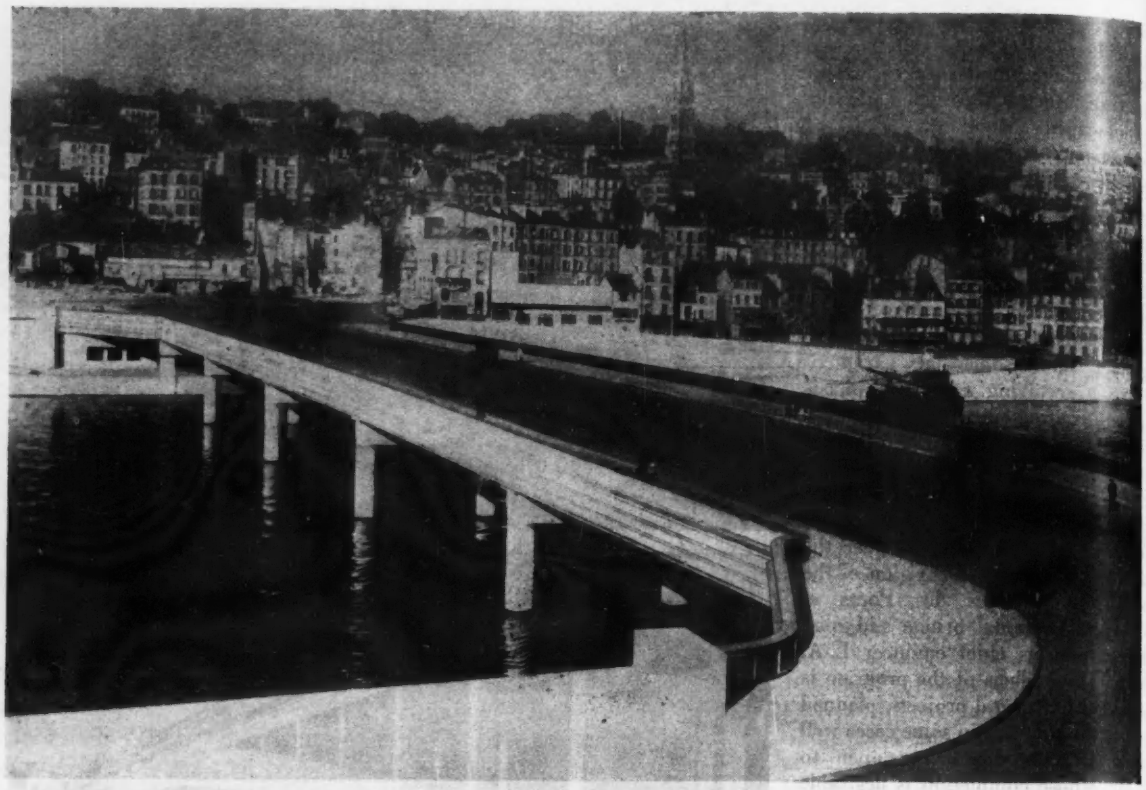


Fig. 3. Five 100-ft. welded continuous girder spans carry the projected Paris-Versailles superhighway over the Seine at St. Cloud. Corrugated copper sheets mask the girders as part of the architectural motif.

sive structure. The railing, it will be noted in Fig. 2, is a light concession toward decoration. It borders a 116-ft. deck accommodating two 25-ft. sidewalks and a 66-ft. roadway. Provision is made for widening the roadway to 88 ft. by reducing the width of the sidewalks. The bridge provides a waterway opening 20x50 ft. at highest navigable water level.

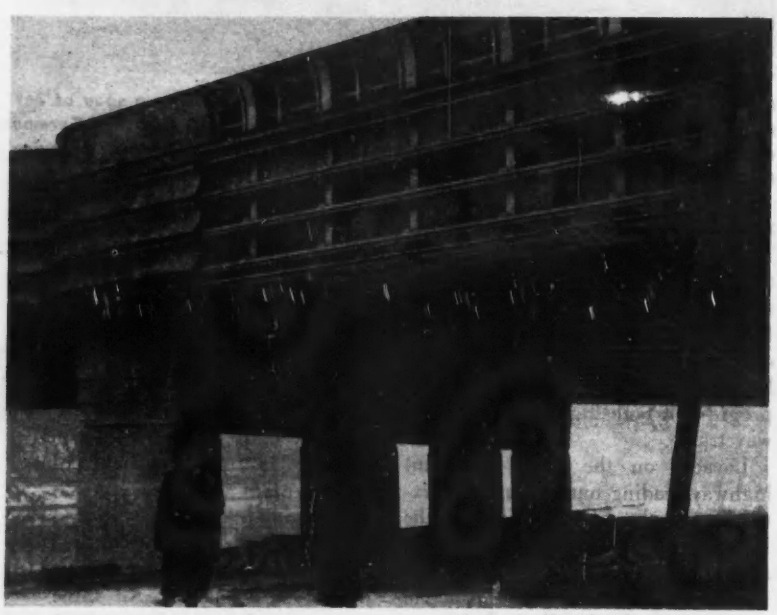


Fig. 4. Germans started to remove corrugated copper sheet enclosure from St. Cloud bridge, but inexplicably abandoned the idea.

The erection of the Neuilly bridge was carried out with the aid of a two span steel truss construction bridge supported above it on the abutments and on a center pile pier. Two bridge cranes operating on rails at about midheight of the trusses lifted the ribs into place on hangers where the field joints were welded. The number of these joints was reduced to the minimum possible, and as a result some of the erection pieces were as much as 75 ft. long. Final adjustment of the ribs as to span length and rise was obtained by hydraulic screw jacks set behind the hinge pins. During all of this work, traffic was not interrupted since the parts of the new bridge up and downstream of the old bridge were completed before the latter was removed.

Girder spans of 100 ft. welded

Another notable bridge, finished and placed in service early in the war, is the one at St. Cloud, but since it is a part of the great superhighway project from Paris to Versailles, there are still things to be done to its approaches and on its ramps that lead down to the quayside. Replacing a

16th century bridge of ten spans that had been destroyed by floods and wars and rebuilt countless times, the new bridge at St. Cloud consists of five 100-ft. welded girder spans, arranged in two continuous units of two and three spans respectively, plus two spans of 48 ft. over the quayside roadways. As with the Neuilly bridge, this structure at St. Cloud was built of high strength chrome-copper steel.

A feature of the welded girders is the use of a specially rolled flange section, in the form of a stubby T, the leg of which is perhaps 2 in. long and beveled to facilitate making a butt weld splice with the end of the web plate, also beveled. The girders are 60 in. deep. Welded Vierendeel frames are used as sway braces between the lines of girders, of which there are 13 in the 98-ft. width of the bridge (which is more than twice that of the old structure).

The piers of the bridge are also somewhat unusual. Founded on piles, they consist of solid walls 7 ft. thick up to about 2 ft. below low water where they support three 6-ft. dia. spirally reinforced columes that are capped at deck level with a 5-ft. deep concrete beam. Rigid and sturdy to resist damage from barges, the piers are one of the pleasing architectural elements of the bridge.

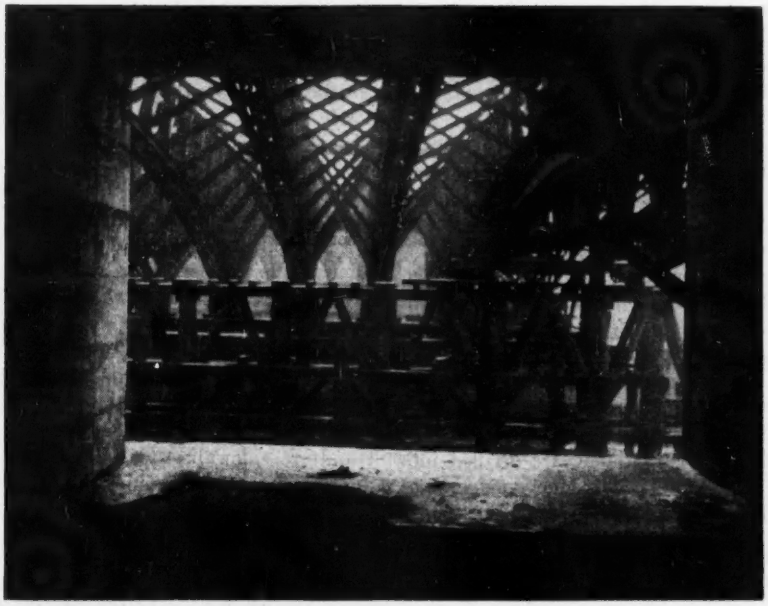


Fig. 5. Structural reinforcement is used to support concrete forms in the Suresnes bridge, a concrete cantilever of 259-ft. main span. This underneath view, taken in March, 1945, shows the reinforcing ready to receive the forms.

Extra care was, in fact, expended to give the St. Cloud Bridge a distinctive appearance, two outstanding results being apparent in the copper sheet enclosure of the exterior girders and the use of exposed vari-colored aggregates in all pier, abutment and retaining wall surfaces. The copper sheets, pressed into corrugations running longitudinally to accentuate the straight lines of the bridge, are hung from special outrigger framing that extends up to the bridge railing. Also, copper sheets, smooth on the outside but set off in vertical panels on the inside bordering the sidewalk, enclose the railing. In all, the height of this copper band, masking the

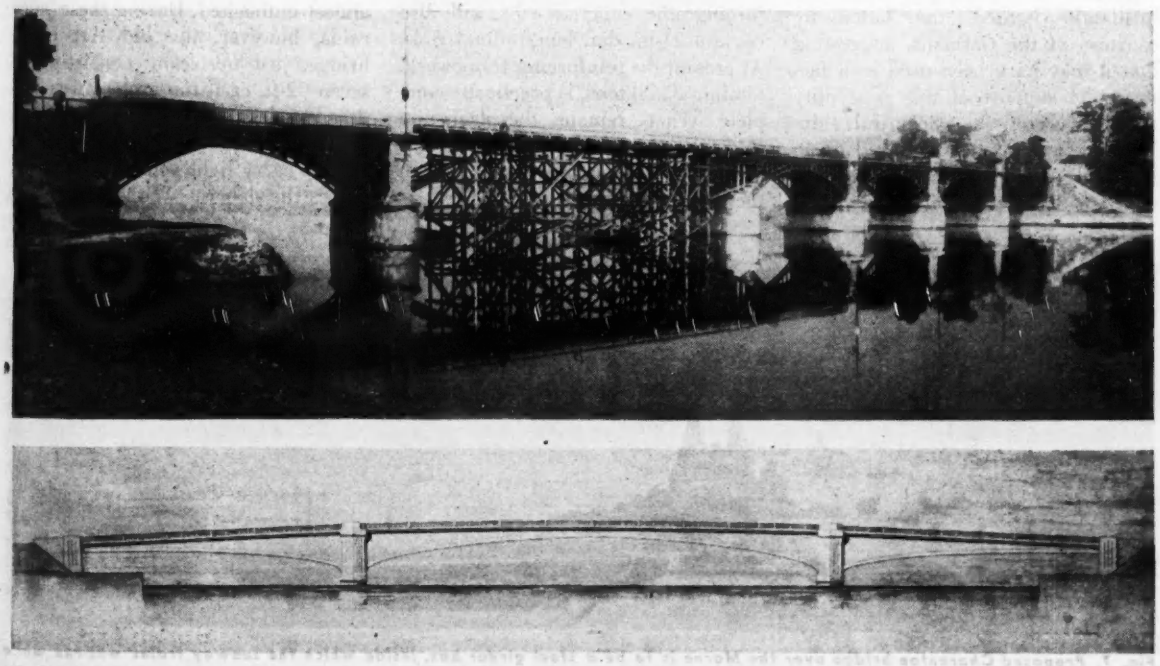


Fig. 6. Present and projected Bezons bridges typify the improvements planned for the Seine below Paris. Old bridge contains seven 65-ft. cast iron arches; two were destroyed. New bridge has a two-hinged central concrete arch of 310-ft. span.

bridge superstructure, is over 10 ft. This inviting supply of copper was dipped into by the Germans several times, but a surprisingly small percentage of the total is missing.

The exposed aggregate surface of the concrete is obtained by air brush rubbing. As is common in the United States, the special-aggregate concrete is placed in only a 2-in. surface layer, a form being used to separate it from the interior concrete and being progressively pulled out as the mixes are deposited.

One feature of the long retaining walls, which line the quayside roads that pass under each end of the bridge, is that they are divided into full-height panels the surfaces of which are made concave. The panels break up the large plain surfaces and are accentuated by the curves, which create shadows that vary with different positions and intensities of the sun.

It was mentioned that the St. Cloud Bridge was a part of a projected superhighway. Evidence of this is available in a large traffic interchange circle at its western end, and about 300 yd. farther on in a half-mile long tunnel at the end of which the new construction stops. The tunnel itself is an accomplishment of first magnitude being a multi-centered arch 56 ft. wide and 26 ft. high at the crown. It is lined with white glazed tile and brilliantly lighted, the latter by courtesy of the Germans, suggesting that it may have been used as a factory. In support of this possibility there are hundreds of beautiful, shining and new torpedoes racked up in it, and the entrance is carefully camoflaged with a net garlanded with the plastic leaves that the Germans used so extensively for this purpose. The tunnel is described in detail in the *Annales des Ponts et Chaussées*, Aug., 1941.

Reinforcing carries forms

Between St. Cloud and Neuilly is the Suresnes Bridge, begun in 1937 but discontinued in 1942 and thus offering a large postwar project. Leading to the Bois de Boulogne, it will replace an old bridge whose spans obstructed barges attempting to negotiate a lock immediately downstream. Because of better approaches and a wide deck (66-ft. roadway and two 16-ft. sidewalks), it will also be an improvement for vehicular traffic.

The Suresnes bridge is to be a concrete cantilever of 259-ft. span, with 130-ft. anchor spans reaching to either bank, and distinguished by the use of welded structural steel reinforcement that was erected first so as to provide a support for the concrete forms. The framing of the anchor spans and the cantilever arms consists of ten lines of curved-bottom chord trusses braced apart by double-diagonal sway frames as shown in Fig. 5. Suspended sections at the center of the main span, hinged between the cantilever arms, take the unusual form of riveted plate girders, which also will be encased in concrete.

In addition to the structural reinforcing, the concrete ribs will also contain 2¼-in. dia. longitudinal rods. At present the reinforcing framework, totaling 2,200 tons, is practically complete. There remains the placing of 28,500 cu. yd. of concrete in the superstructure, and the completion of the approach work.

Downstream from Paris and about seven miles below the Neuilly bridge occurs the Seine crossing nearest to the city which was damaged by our August, 1944, bombing. This is the bridge at Epinay which carries one of the important northwest exit highways across two arms of the river on metal arches. Our bombs knocked out some of the floor in the longer span, while the bridge over the small arm had been entirely destroyed in June, 1940. Designs have now been prepared for a replacement structure over the small arm to consist of a continuous reinforced concrete beam superstructure in three spans—82, 133 and 82 ft.

Next downstream is the new Argenteuil bridge on which work was begun in 1939 and then abandoned in 1942 after the foundations had been completed, the steel fabricated and one span erected. The bridge is destined to consist of three steel deck arches—200, 218 and 200 ft.—of chrome-copper steel. A 58-ft. deck will accommodate a 40-ft. roadway and two 9-ft. sidewalks. The central span provides a navigation opening 100 ft. wide by 20 ft. high; the side spans 65 ft. wide by 18 ft. high.

Early completion vital

Although the Allied bombing of 1944 destroyed most of the contractor's plant, the bridge itself remained almost untouched. During these same raids, however, the old Argenteuil bridge, just upstream, consisting of seven 92-ft. cast-iron arches, was rendered useless, and a wooden bridge, principally for pedestrians but also able to carry light vehicles, was built across the debris. With such inade-

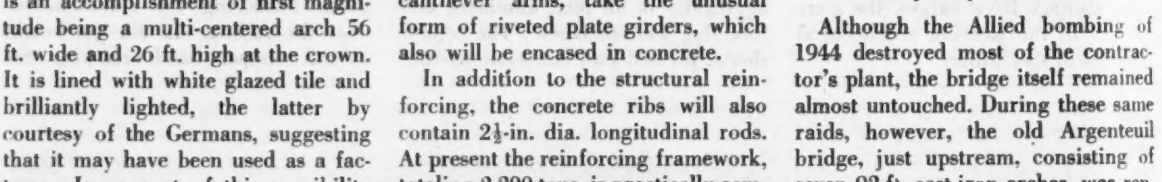
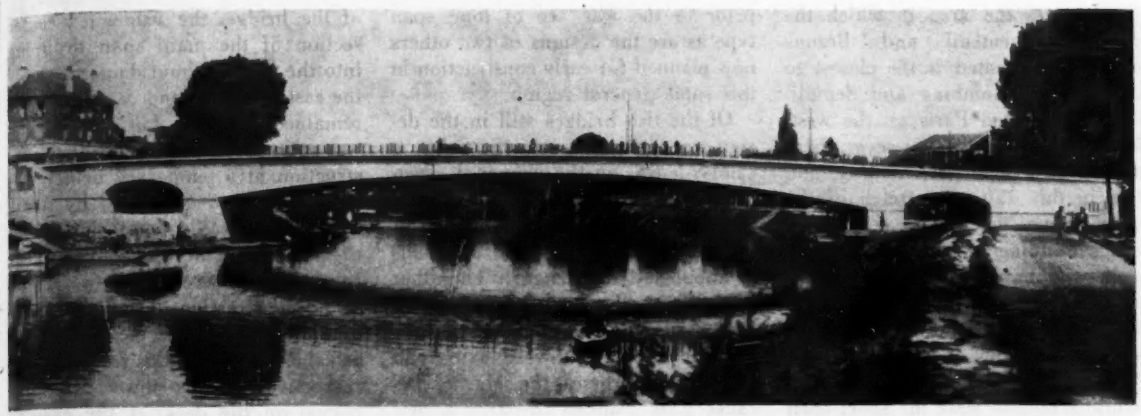
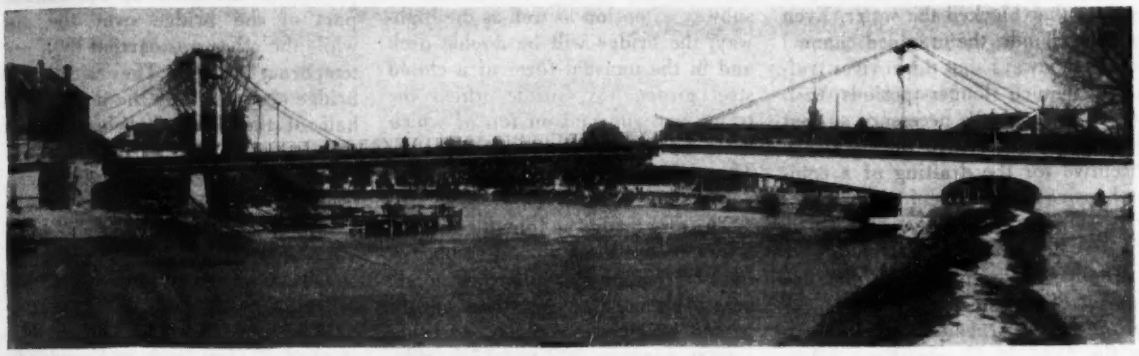


Fig. 7. Proposed Charenton bridge over the Marne is to be a steel girder box, inside which the subway trains will run while the highway is accommodated on top. The "portholes" in the above view identify the girders. A concrete arch carries the construction over an old canal, while the existing stone arch bridge is just upstream.





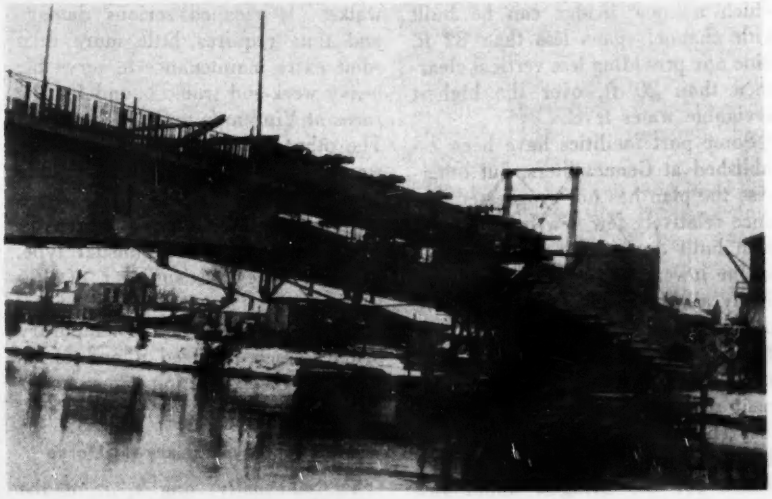


Fig. 8. Three views of the concrete cantilever bridge at Bry-sur-Marne—as it looked after completion in 1938; as it existed after demolitions destroyed its west half in 1940, requiring replacement with a temporary suspension bridge; and as it is being reconstructed to the original design today. The steel girders in the bottom view are supports for lifting the original center section from the river bottom.

quate facilities on one of the busy radial highways in the Paris region, the need for speed in completing the new bridge is obvious. According to the latest estimates, the cost will amount to approximately 55 million francs, and it is hoped to complete the bridge by early 1946, although a plan to modify the design to increase the navigation clearance from the present 20 ft. to 26 ft. may make this impossible.

The third of the damaged bridges below Paris requiring replacement is at Bezons and consists of seven 65-ft. cast-iron arches, each containing four ribs on which rest a 19-ft. roadway and two 7-ft. sidewalks. One span of this bridge, blown up in June, 1940, by the French Army Engineers, was replaced by a timber scaffolding built by the German "Organization Todt", and this temporary construction is still serving.

In the meantime, work is commencing on a bold new bridge of concrete cantilever type, which was designed during the war after a design in steel had proved impossible to carry out in 1940, even after the contract was let, because of unavailability of the material. This steel design involved a three-hinged 360-ft. span main arch connected to the banks by 150-ft. cantilevers tied down to the abutments by prestressed anchor rods. The adopted concrete design, interestingly enough, follows the same general pattern, except that the spans are 180, 310 and 180 ft. It is admitted that construction of the 310-ft. central span will occasion some very special erection procedures, which are still in the course of development. The bridge, with a 65-ft. roadway and two 11-ft. sidewalks, will be built on the same alignment as the old crossing, which will be demolished as soon as a temporary bridge is erected some 600 ft. upstream. Construction of the temporary structure is under way.

As stated, the area in which the Epinay, Argenteuil and Bezons bridges are located is the closest to which bridge bombing and demolitions approached Paris on the west. Below here, to the sea, however, there are few structures left standing, and it is in this 120-mile stretch of the lower Seine that a great postwar bridge building opportunity presents itself, with an objective that France has been planning for since 1910. In that year a great flood devastated the Seine River valley and large parts of Paris itself. One of the chief contributing factors were the short span bridges that blocked the water. Even in lesser floods, the cramped channel openings always shut down river traffic for much longer periods than otherwise would be necessary so that the big flood provided the necessary incentive for the drafting of a comprehensive improvement plan.

Postwar plans for lower Seine

The basic elements of this plan are the establishment of a larger river terminal near Argenteuil, to be known as the Port de Gennevilliers, below which no new bridge can be built with channel spans less than 82 ft. wide nor providing less vertical clearance than 20 ft. over the highest navigable water level.

Some port facilities have been established at Gennevilliers, but otherwise the plan has not progressed far, since relatively few new bridges have been built during the past 35 years on the lower Seine. Now that practically all of the crossings there have to be replaced or extensively repaired, there is much hope and some optimism that this great bridge improvement plan will be carried out. The cost (based on 1939 prices) is estimated at one thousand million francs for the bridges, about two hundred million of which has recently been added by a change in the vertical clearance requirements from 20 to 26 ft. to accord with modern shipping needs.

Although the bridge clearances required by the 1910 order are not mandatory upstream from Gennevilliers, they have nevertheless been followed and in some cases exceeded as is evident from the dimensions of the bridges described above. And even upstream from the city itself, in the comparatively distant suburbs on the Marne, two new bridges built just prior to the war are of long span type as are the designs of two others now planned for early construction in this same general region.

Of the two bridges still in the design stage, the one over the Seine at Choisy-le-Roi on the principal circular road around Paris will be of reinforced concrete with a main arch of 220 ft. and two cantilever side spans of about half that length. The other bridge, for which a new design has been prepared, is at Charenton, where an important southwest exit road from Paris crosses the Marne. Because it is planned to carry a new subway extension as well as the highway, the bridge will be double deck and in the unusual form of a closed steel girder box, inside which the trains will run and on top of which the roadway will be accommodated. The main channel span will be about 140 ft. long.

The new bridge at Joinville-le-pont, begun before the war and completed in 1942, is of two-hinged concrete arch type and has two spans of 248 ft. and 121 ft., respectively, carrying a 50-ft. roadway and two 15-ft. sidewalks. It escaped serious damage and thus requires little more than some extra maintenance to serve the heavy week-end traffic bound for the races at Vincennes and Le Trembley. The other bridge, at Bry-sur-Marne, was not so fortunate, suffering the loss of more than half its length to French demolition charges in 1940. Of somewhat unusual type, being a concrete cantilever of 186 ft. span, this latter bridge is also interesting by virtue of the temporary bridge which replaced it and of its postwar reconstruction now under way.

Long cantilever at Bry-sur-Marne

The unusually long span of the Bry-sur-Marne bridge is shown in Fig. 8, where its construction is also evident, involving a suspended center section between the two 75-ft. cantilever arms of the main span and anchor spans in the form of 31-ft. concrete arches whose heavy abutments are anchored to the foundations by steel rods. The six longitudinal girders of the bridge support a 33-ft. roadway and two 13-ft. sidewalks.

On June 14, 1940, Engineers of the French army set off demolition charges that destroyed the west half of the bridge, the suspended center section of the main span dropping into the river without damage. Only the east approach and cantilever arm remained standing, but the crossing was so important that immediate construction of a temporary bridge was undertaken and completed by April, 1941. This was a suspension bridge of 186-ft. span in which towers with reinforced concrete legs were utilized. Steel castings installed over the tops and bottoms of the legs served as cable saddles and as rocker hinges respectively. One tower was supported on the deck of the existing part of the bridge over the pier while the other was carried by a new temporary pier. The suspension bridge occupied only the downstream half of the permanent bridge, thus permitting partial reconstruction to be carried on without interrupting traffic.

Completion set for late 1946

This reconstruction was, in fact, begun in September, 1941, and continued for a year, when the Germans stopped all civil work in France. By that time the west anchor span and cantilever arm in the upstream half of the bridge were complete.

From this point on, rebuilding of the Bry-sur-Marne bridge is a postwar job, and one that is now under way. As shown in Fig. 8, steel I-beams have been placed across the opening between the two cantilever arms from which tackle will be suspended to lift the upstream half of the suspended section of the main span from its resting place on the bottom of the river. With this section in place, the upstream half of the permanent bridge can be opened to traffic, the suspension bridge removed, and reconstruction of the downstream part of the bridge undertaken. The present schedule, based on critical shortages of materials, calls for completion of work on the Bry-sur-Marne span by October, 1946, at the latest.

The bridge jobs mentioned above represent the most obvious postwar work in the immediate Paris region. They are not numerous, nor are they likely to be, considering the bridge needs of other parts of the country, but they represent a start toward planning and working for a future in which peace and not war is the prime objective.

Gunite Tunnel Lining Test Reveals Difficulties in Application

Careful study was given to the problem of finding the best means of putting a watertight lining in the Oak Grove pressure tunnel that serves one of the hydroelectric plants operated in Oregon by the Portland General Electric Co. The tunnel is about 14 ft. in diameter and may be subjected to static heads up to 250 ft. which suggested either steel pipe or a well-reinforced concrete lining. Proponents of a plan for building up a lining with circumferential reinforcing bars covered with a coating of gunite believed this would be a satisfactory method and that it could be employed at a cost saving of about $40,000 over the next most economical method.

In order to try out the gunite proposal, a wooden form simulating a short section of the 14-ft. tunnel was built up, the proposed layers of reinforcing steel were put in place and gunite was shot over the steel from the inside of the test section. In all respects the application of the gunite was made under conditions that were, as nearly as could be, the same as those that would obtain in the tunnel.

In one half of the section all of the reinforcing steel in the double layer was put in place before the gunite was applied. In the other half only the first or outer layer of steel was placed before the first gunite was applied, after which the second steel layer and the second gunite applications were put on. The test section included both round and square bars. The operator was a man with 17 yr. of experience in handling gunite equipment.

Fig. 2. Sand pockets behind the steel bars were so serious that the plan for using this method was abandoned.

Fig. 1. Applying gunite lining over reinforcing steel in a test section simulating a tunnel 14 ft. in diameter.

When the forms on this test section were removed there was evidence of a strong tendency for the spaces directly back of the reinforcing bars to collect sand with little cement in it. When the gunite shell was broken by means of a pneumatic hammer, lose sand was also found in back of the second layer of reinforcing steel.

As a result of the test it was decided that sufficient bond could not be assured to develop the full strength of the steel. For this reason and also because this method would not give the steel adequate protection against corrosion, it was decided that some other lining method should be used.

Data for this report on the test was supplied by John Bankus, chief engineer, Portland General Electric Co., Portland, Ore.

Laws in 12 States Zone Airport Hazard Areas

Twelve states passed zoning laws governing the construction and location of structures within airport hazard areas during current legislative sessions, the American Society of Planning Officials reports. The states taking action are: Florida, Illinois, Iowa, Nebraska, New York, North Carolina, Oklahoma, Pennsylvania, Tennessee, Utah, Washington, and Wisconsin.

The majority of the laws took the form of the Iowa legislation, which allows political subdivisions to adopt airport zoning regulations to limit the heights of nearby structures and to eliminate other hazards. For example, Illinois authorizes the department of aeronautics, municipalities and other political subdivisions to exercise zoning powers and in addition to acquire air rights and other interest in land to prevent creation of and to eliminate hazards to air navigation.

Besides containing regular zoning provisions, the North Carolina law provides for the acquisition, construction and maintenance of airports. Tennessee authorizes the expenditure of public funds for the elimination of airport hazards.

Wisconsin towns or counties may acquire property for airports under the power of eminent domain. Also, municipalities of adjoining states may acquire land for airports in the state under a reciprocal grant of authority to Wisconsin municipalities.

Variety Characterizes Refuse Disposal Practice in Six Large Cities

Probably no other function of municipal activity shows greater variety in method than that of refuse collection and disposal. These differences reflect the influence of topographic conditions, historical precedent and popular sentiment. In recent years, with the concentration of activity in war production centers, unprecedented burdens have been placed on existing refuse disposal facilities to cope with additional volumes of waste. Experiences in some of the larger communities are outlined in the following report, which indicates the variety and the types of disposal now being utilized in six typical American cities.

DALLAS DUMPS IN OLD GRAVEL PITS

Employing 166 men, 45 motorized trucks and 24 teams in its Garbage Division, the city of Dallas collects and disposes of an average of 9,630 tons of garbage each month at a yearly cost of $1.10 per capita, according to J. T. Conroy, director, Department of Public Works. All garbage and refuse are wasted on three dumps located in widely separated districts. The cost of operating the dumps averages $2,950 per month. Brush and grass are dumped in an open space and set on fire at frequent intervals.

The smallest dump covers 3½ acres which previously was an old gravel pit. Sufficient earth excavation is secured close by to cover the garbage to a 2-ft. depth after the pit is filled to an agreed level. The second dump covers 30 acres, consisting of several old gravel pits into which refuse is dumped and converted into a sanitary fill by covering with earth. The third dump is an open space on which garbage is deposited and rolled. Eventually it will be covered with dirt.

Dallas recently purchased a "Bull-clam" tractor for use on the various dumps. It is believed that this equipment will greatly increase the efficiency of the sanitary fill method as it permits digging the trench and covering the garbage as it is dumped. It also should aid materially in the elimination of rodents, flies and the undesirable odor heretofore tolerated.

Five of the city's motorized trucks, operating 16 hr. per day, collect refuse nightly in downtown Dallas. Six of the city's trucks are of the enclosed packer type. One man with a pickup truck collects small dead animals which are disposed of in an old incinerator.

SANITARY LANDFILL AT SEATTLE

THE SANITARY FILL METHOD of garbage and refuse disposal has been used exclusively for the past several years in Seattle, according to C. L. Wartelle, city engineer, Department of Public Works. This method has proved both economical and quite satisfactory, and much land has been reclaimed through its operation.

Seattle, with a population of 480,000, does not collect garbage, ashes or other refuse with its own city forces. Instead, such material is collected regularly by a local company operating under a $679,500 lump sum yearly contract. In addition, the contractor furnishes about 100,000 cu. yd. of earth for covering, at $0.60 per cu. yd. The money is paid from the city's general fund. Last year over 1,250,000 cu. yd. of garbage and refuse were collected and disposed of by the contractor. The city also has a contract with another agency for the collection of hog food, or swill. This contractor pays the municipality $100 per month for the exclusive privilege of collecting such waste.

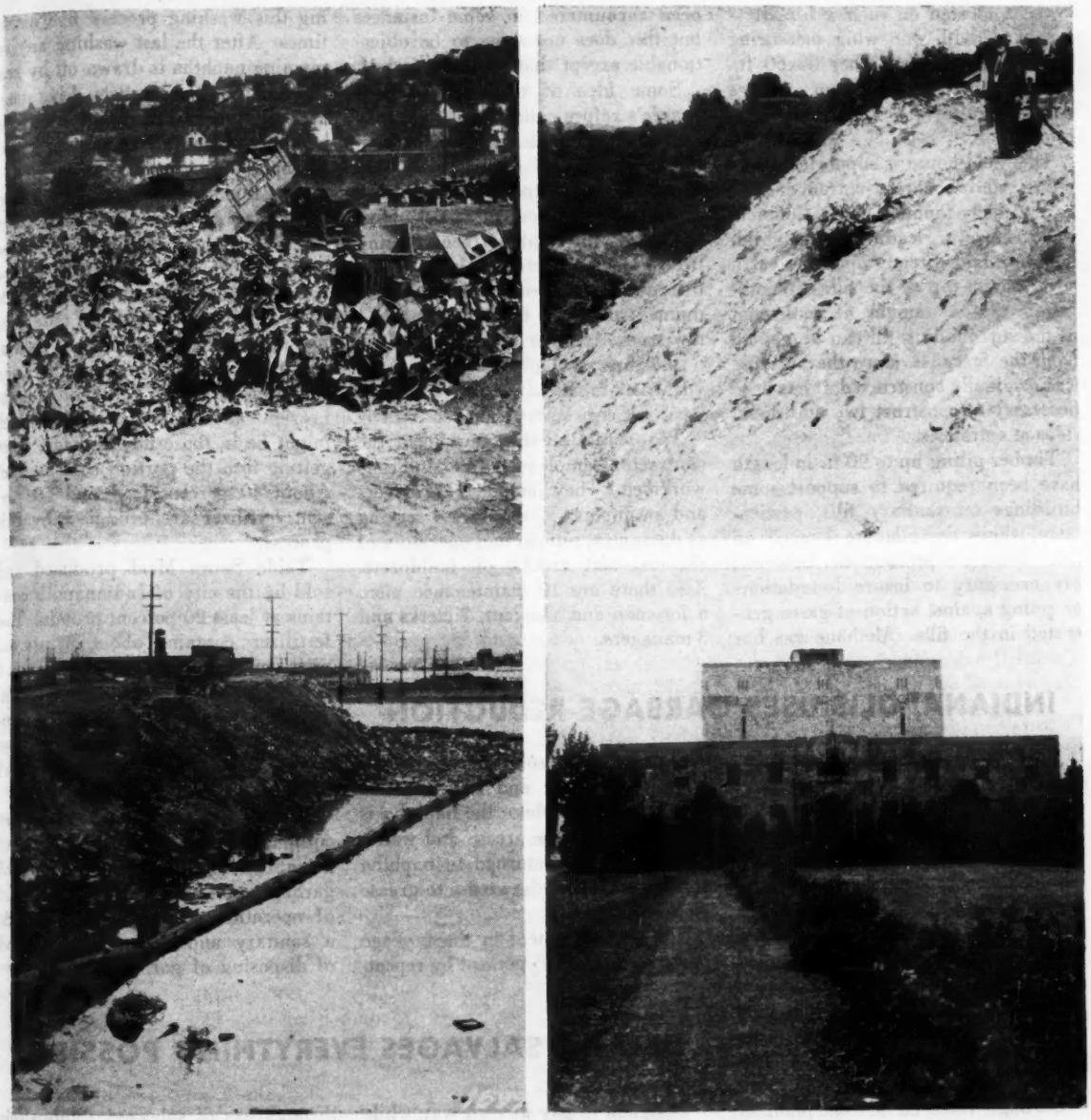
Under the current system industrial wastes are excluded from free city collection. Manufacturers and others having excess waste not covered by free collection are of necessity compelled to either haul the material to the sanitary fills or to fire dumps provided by the city.

Three fire dumps

Three fire dumps are maintained by the city at strategic centers, located so as to cause no nuisance from smoke. All inflammable material such as refuse from shipyards, airplane factories, army and navy barracks, together with shrubs, trees and other like refuse from private residential premises is burned on the dumps. The top surface or floor of the fire dumps are covered with earth, gravel or cinders, making them accessible at all times to vehicles. The city makes no charge for the use of its fire dumps.

All sanitary fills are operated by the city. There are at present six fills in all, located in close proximity to either the residential sections or industrial areas. Each site was selected with a view toward utilizing it eventually for recreational purposes, the erection of buildings or for the storage of materials. At one of the larger fills the city is building an 18-hole golf course and other recreational facilities. This fill is being covered with 18 in. of earth plus a top-soil dressing and, based on past experience with similar fills, no interference in the growing of grass and shrubs is anticipated from any methane gas which may be generated by decaying refuse. In some fills methane gas has been found to persist for ten to twelve years after a fill has been completed.

Each sanitary fill is built and maintained so as to cause as little public



Typical operations in Seattle's sanitary fill method of refuse disposal include: (A) Earth covering applied and compacted immediately after refuse is dumped to avoid creating a public nuisance; (B) sanitary fills are built to 45-deg. slopes; (C) timber boom controls floating refuse where fill is made in salt water flats subjected to tidal flow; and (D) Green Lake playfield is representative of a sanitary fill recreational development.

offense as possible. The refuse is dumped directly from the collector trucks onto the floor, or top surface, of the dump and bulldozed over the active face of the fill. The width of active face varies considerably, depending on the number of loads delivered daily. Contract specifications, however, call for each fill to progress at a rate of at least 5 lin. ft. in each day's operation. At present the most active fill is 110 ft. wide while one of the smaller fills, which receives a relatively small amount of refuse daily, has only a 70 ft. wide active face. Following the thorough compaction of each lift, the garbage is covered with about 12 in. of earth. Side slopes of the fills are maintained on a 45-deg. slope. They also are kept covered with earth. All cracks in the fills are filled regularly to prevent fires and the escaping of noxious gases, such as methane.

Settlement of fills

Settlement of Seattle's sanitary fills continues for many years after they have been completed, and, for that reason, it is not deemed advisable to construct heavy buildings on them. The degree of settlement depends upon several factors; character of the subgrade, location of the water plane, the height of fill and the composition of the refuse. This settlement is sufficient to cause damage to superimposed structures, roadways or sidewalks unless adequate foundation other than refuse is provided. The Green Lake fieldhouse, shown in the accompanying illustrations (d), how-

ever, is located on such a fill. It is L-shaped, with one wing measuring 75x109 ft., and the other 60x60 ft., and contains a gymnasium, a stage and an auditorium, and recreational rooms.

This field house is supported on fir piling, and concrete entrance steps have pile foundations. Concrete walks, however, leading to the building were laid directly upon the earth covering on top of the fill. An indication of the amount of settlement of the surrounding fill can be gained from the fact that, since the building was originally constructed, it has been necessary to construct two additional steps at entrances.

Timber piling up to 90 ft. in length have been required to support some buildings on sanitary fills, particularly where the fills are located on tidal flats. No precautions, however, are necessary to insure foundations or piling against action of gases generated in the fills. Methane gas has been encountered in some instances but this does not seem to be objectionable except that the odor is bad.

Some idea of the magnitude of Seattle's refuse collection system may be gained from the amount of contractor equipment required. A total of 63 garbage trucks are used including seven 12-cu. yd. trucks, five 14-cu. yd., thirty nine 16-cu. yd. and twelve 18-cu. yd. trucks. In addition, the contractor operates ten 5-cu. yd. dump trucks, 3 flat-bed trucks, 1 tow truck, 1 trailer, 1 gasoline truck, 5 pick-ups, 4 bulldozers, one $\frac{3}{8}$-cu. yd. truck-mounted shovel and one $\frac{3}{4}$-cu. yd. crawler-type shovel.

To operate all this equipment the contractor employes 149 full-time workmen. They include 117 drivers and swampers, 12 employees serving as dumpmen, pitmen and operators of shovels, dirt trucks or bulldozers. Also there are 10 maintenance men, a foreman and assistant, 7 clerks and 3 managers.

INDIANAPOLIS USES GARBAGE REDUCTION

Garbage in Indianapolis is delivered by city-owned and operated collection trailers and compression trucks to a reduction plant where it is reduced to hog food and commercial fertilizer, reports Sherlie A. Deming, president, Board of Public Works and Sanitation. From 27,000 to 30,000 tons of garbage are handled yearly in this city-owned reduction plant. It varies from 1,400 tons during the winter months to 4,000 tons per month in late summer and early fall.

Garbage received at the plant is first conveyed over a picking belt where paper, tin cans, glass and other extraneous materials are removed. From there it is conveyed to 32 vertical steam jacketed cookers, 5 ft. in diameter and 12 ft. tall. After cooking the garbage for two hours by steam induced through nozzles near the bottom of the cooker, the grease is skimmed off by hand, the vessel is closed and the cooked garbage is vacuum dried to about 3 percent moisture.

From the cooker room the tankage is conveyed over a second magnetic separator to remove all metallic objects and placed in degreasing vessels similar in design to the garbage cooker. After these vessels are filled with naphtha, the solution is drawn off from the bottom and sent to stills and condensers where the naphtha is separated from the grease and water. The naphtha is returned to naphtha storage tanks and the grease to grease storage tanks.

The grease content in the tankage is reduced to 3 to 5 percent by repeating this washing process five or six times. After the last washing any remaining naphtha is drawn off by heat through the steam jackets. Live steam also is induced directly into the tankage to displace all remaining traces of naphtha.

The remaining degreased tankage then is run over cylindrical screens where the lighter portion is air-floated to storage bins. Later, it is sacked and sold as feed under the trade name, "Table Scrap Meal." Material passing through the screen is sold as fertilizer. Tailings are reground and run over the screen a second time to prevent any glass particles, which might be in the crude tankage, from getting into the portion sold as feed. About 40 percent feed and 60 percent fertilizer are produced by this process.

Table Scrap Meal produced and sold by the city of Indianapolis contains at least 20 percent protein. The fertilizer contains about 3 percent nitrogen, 2 percent phosphorous, 1 percent potassium and 13 percent ash. This product usually is sold to commercial fertilizer concerns as a base for the more concentrated forms of fertilizer.

While the maintenance cost on equipment is relatively high due to the abrasive and corrosive action of garbage, the plant pays for its cost of operation and is said to provide a sanitary and dependable method of disposing of garbage for the city.

DETROIT SALVAGES EVERYTHING POSSIBLE

Designed to pay its own way while helping solve an increasingly difficult problem of finding space for the disposal of garbage and rubbish, a new refuse salvage plant was put into operation in Detroit, Mich., last December. According to G. R. Thompson, city engineer, it is expected that capacity operation of the plant will prolong availability of present disposal dumps through salvaging materials that take up considerable space in dumping areas, which are rapidly approaching depletion near the Michigan city.

Sale of salvaged non-combustible materials — scrap metal, tin cans, glass, paper and rags—will help reduce overall garbage and refuse disposal costs, as will savings effected through use of salvaged combustible materials as fuel in incinerator plants. Hauling costs will also be reduced. This results from the central location of the new salvage plant as compared with Detroit's present disposal centers outside the city limits, now necessitating a haul of 12 miles for disposal of about 40 percent of the total refuse volume of the city. This includes approximately 2,600,000 cu. yd. of rubbish each year.

Rubbish arriving at the plant is dumped from trucks into a receiving bin having a capacity of about 6,000 cu. yd. Two 10-ton cranes equipped with 5-yd. clam shell buckets transfer the rubbish from the bin to skip hoist loading hoppers. It is then elevated approximately 60 ft. by means of two

yd. automatically operated skip ists, which discharge onto feeder nveyors. These conveyors carry the bbish to a grizzly bar screen where es are separated from the other ma-rial.

The bar screen discharges onto a -in. belt conveyor equipped with a agnetic pulley that separates the tin ns and other small ferrous material om the refuse. The remainder of e refuse then passes along a belt nveyor from which various mate-als are picked by hand and dis-rsed into bins underneath. Paper d rags are baled and tin cans are edded.

A railroad siding is provided so that the salvaged materials may be loaded directly into cars. Unsalvaged refuse is carried by another conveyor into an adjoining incinerator.

The plant, designed to handle 2,000 cu. yd. of rubbish in an 8-hr. day, is expected to yield daily 6 tons of scrap metal, 26 tons of tin cans, 16 tons of glass, 1½ tons of corrugated paper, 14 tons of mixed paper and 2 tons of rags.

As regards fuel savings, it is estimated that for every 5 tons of combustibles salvaged and used as incinerator fuel, one ton of coal is saved. On this basis, Detroit officials expect to reduce by $40,000 the city's present annual $100,000 incinerator fuel bill.

ST. PAUL OPERATES HOG FARMS

About 75 percent of the garbage in t. Paul, Minn. is collected by some 3 farmer collectors for feeding hogs, eports Geo. M. Shepard, chief engi-eer, Department of Public Works. hese private collectors pay a $10.00 cense annually. The remaining 25 ercent of the garbage is collected y the city and fed to hogs at the 40-acre St. Paul Workhouse Farm cated in the city's easterly outskirts.

Collections by the city are made eekly, although private collections overing downtown district hotels nd restaurants are in some cases ade daily. Last year some 24,000 ns of this hog-feeding garbage were ollected, of which the city collected ,000 tons.

Operation of St. Paul's City Work-ouse by prisoners serving Municipal ourt sentences is under the jurisdic-on of the Department of Public Works. These prisoners are employed on the Workhouse Farm. Hogs of feeder size (125 to 175 lbs.) are purchased by the city at the local live-stock market, fattened on the farm, and marketed when they attain 275 lb. in weight. Considerable profit has been reported during the past few years from this city hog-feeding program.

The collection of refuse, other than garbage, is performed in St. Paul by private collectors who are licensed annually. In accordance with a city ordinance all refuse and waste within the city limits are deposited on fire dumps, supervised by watchmen. No estimate is available regarding the amount of refuse handled yearly. The adequacy of both garbage and refuse collection throughout the city is the responsibility of three full-time inspectors. During 1944, St. Paul spent about $50,000 collecting its share of garbage.

NEW ORLEANS RELIES ON INCINERATION

All garbage and combustible refuse ollected by city forces in New Or-ans is disposed of in five incinera-rs owned and operated by the city, eports Michael J. Kelly, deputy com-issioner. In the near future, the city lans to build a large incinerator to eplace three of the present ones, now early obsolete. The new plant also ill be large enough to burn commer-ial waste, most of which is disposed f now by dumping.

Collections of garbage and refuse are made six days a week, one of which, Thursday, is devoted primarily to the collection of noncombustible rubbish, tree branches and other trash.

Most of New Orleans' collection equipment is reported to be obsolete. Trucks and trailers equipped with removable bodies have been used for many years. These bodies are unloaded at the incinerators and empty, spare bodies replaced on the collection vehicles. Unlike most cities, New Orleans expects to continue the limited use of mule-drawn equipment. This is because mules continue to be employed for the carnival parades, and the city seems to be the only source from which draft animals can be obtained in sufficient quantities.

Municipal Refuse Service Superior to Contract Work

Refuse disposal by the municipality itself is preferable to contract work because such service can be performed more cheaply and community sanitation assured more readily under such a plan, according to a survey of practices in 121 Minnesota communities by the municipal reference bureau of the University of Minnesota.

Other conclusions based on the survey, which is reported by the American Municipal Association, are:

Some form of municipal collection is carried on in 38 of the Minnesota cities, with a majority requiring compulsory service from one kind of premise or other.

Contract collection is less popular with such a system in operation in only 17 of the municipalities.

About 75 per cent of the municipalities still allow private scavengers to make collections or property owners to haul their own refuse.

Private collection expensive

Private collection may be advisable for municipalities under 25,000 population depending upon care that scavengers take in observing public sanitation and official enforcement of regulations. However, private collection often is expensive because of the need for scavengers to make a profit and the difficulty of enforcement.

Refuse collection and disposal operations are financed from general revenues in 39 of 121 municipalities.

Predominant method of financing is the service charge; 14 municipalities with municipal or contract systems of collection follow such a method.

The best plan of financing is from general revenue because it assures complete service and is based on ability to pay. If funds are unavailable to cover complete service, however, service charges are an acceptable supplement or substitute.

Fig. 1. Absorptive form liners imparted a smooth, wear-resisting surface to the Norfork Dam spillway.

Form Linings for Concrete Surfaces

Harrison V. Pittman,
Principal Engineer, U. S. Engineer Office
Little Rock, Arkansas

***Contents in Brief**—A fabric-covered 1/16-in. thick, absorptive lining was used for forms at Norfork Dam at a total cost of 12c. per sq. ft. Backing the absorptive material with a non-absorptive lining produced better surfaces at a saving of 3½c. per sq. ft. over use directly on wood sheathing, which would have required frequent reconditioning. Methods of application and actual field experience with both types of lining are given in detail.*

TO OBTAIN CONCRETE FREE from surface defects absorptive and non-absorptive liners for the forms were used extensively at Norfork Dam, a large flood control and power development built by the Corps of Engineers, U. S. Army, on the North Fork River—a tributary of the White River in northern Arkansas.

A very thin absorptive lining was used for most of the exposed surfaces above the backfill limits on both upstream and downstream faces of the dam and appurtenant works. Exceptions were horizontal surfaces, the roadway bridge and powerhouse walls, which were to be rubbed later. Non-absorptive lining—plywood or oil-treated compressed board—was used on panel forms to give a smooth surface for the absorptive liner while for many other forms such lining was used for direct contact with the concrete to assure smooth surfaces.

The lining used at Norfork Dam consisted of a thin fabric facing adhesively bonded to an absorptive card board backing. It was about 0.08 in. (1/16+) thick and weighed 0.22 lb. per sq. ft.

Extensive tests had been made earlier, by the Little Rock and the Caddoa district offices of the U. S. Engineers, largely on ½-in. thick fibrous material resembling insulating board. The thinner material appeared to give surfaces equally satisfactory and it was used on limited areas of Nimrod and Clearwater dams in the Little Rock district while the ½-in. thick fibrous board was used on John Martin Dam of the Caddoa district.

COST OF ABSORPTIVE FORM LINING

Total lining purchased	973,143 sq. ft.
Total cost of lining @ $0.04 and $0.0425 per sq. ft.	$40,608.58
Total cost of labor and plant	52,260.97
Total direct cost	$92,869.55
Total indirect cost (20% of direct cost)	18,573.91
Total cost lining	$111,443.46
Area of form-lined concrete surface	948,200 sq. ft.
Volume of concrete surface form-lined	1,120,230 cu. yds.
Unit cost—area basis	$0.1175 sq. ft.
Unit cost—volume basis	$0.095 cu. yd.

Waste in application of the lining was somewhat less than 3 percent.

Absorptive liners had previously en used on Bureau of Reclamation ms and the bureau's experience, th in tests and actual applications, re drawn upon in determining pro-dures for these structures.

By the time construction was under-y at Norfork Dam the fibrous ma-ial was not available due to war nditions and the fabric-faced card-ard type was used exclusively. The rm lining was purchased in sheets ft. x 5 ft. 2 in. and 4 ft. x 6 ft. 3 in. permit ready application to the ndard panel forms in use at the m. The lining was applied after proval of form clean-up and as se as practicable to the time of ncrete placement. It was fastened the forms with type L4C, tin-ated steel staples driven by a sta-ing gun manufactured for the pur-se. As a rule the average spacing staples was 4 to 6 in., with a row staples spanning the vertical ints.

The sheets were mounted with the ng dimension in the vertical direc-on, primarily to avoid horizontal ams, but also to lessen the tendency r the lining to swell and subse-ently wrinkle in the lengthwise rection upon wetting, due to the ct that the cellulose fibers of the cking were oriented in a length-ise direction.

For the non-overflow monoliths, the onstruction lift joints and transverse oints between the monoliths were hamfered 1½ in. and 2 in., respec-vely. After attaching the lining to e form, the chamfer strips were ailed in place over the lining. The own-stream faces of the overflow onoliths were not chamfered and e lining was cut horizontally about in. below the grade-strip prior to lacement of concrete. Upon raising e form, the absorptive backing of e lining was removed over the area in. below grade, leaving the fabric cing in place. After approval of e lift clean-up, the bottom tie rods f the panel were loosened and the rm moved out a short distance. he form lining for the new lift was en placed to lap the horizontal ft joint and the form drawn up tight.

During the early stages of con-ruction it was found that the top art of the lining, necessarily pulled own for alignment of the form for e succeeding lift, had a tendency o loosen or remove paste from the surface near the lift joint because of adhesion between the liner backing and the concrete surface as well as the low strength developed in the concrete paste. During the cooler days, curing water from spray jets placed along the lower part of the forms had a tendency to erode these areas, creating an unsightly surface. This condition was aggravated with the approach of cold weather which further retarded the setting time of the normally slow setting low-heat cement.

Fig. 2. Fabric facing pulled away from the absorptive backing of .08-in. thick form lining.

The absorptive backing of the lining separates quite easily from the fabric facing when wet. Accordingly, the absorptive backing was cut for the full width of the monolith about 6 in. below and parallel to the grade strip prior to concrete placement. Upon stripping the form, the absorptive backing of the lining could be removed for a distance of 6 in. below the lift joint without removing the fabric facing. Thus, loosening or pulling away the mortar from the surface near the joint was eliminated and the form for the succeeding lift could be placed without interference from the lining of the lower lift.

The lining was stapled directly to 1-in. form sheathing during its early use while the forms were still in good condition. However, after the forms had been used several times, the surfaces deteriorated and it was found necessary to re-dress them by sanding to smooth out warped boards and to correct other flaws to obtain a satisfactory concrete surface. To eliminate sanding of the used forms, the contractor elected to cover the forms with a non-absorptive backing for the absorptive lining. This procedure is described subsequently.

The absorptive form lining developed sufficient adhesion to the concrete surface to remain in place after the removal of forms. The limited previous experience with this type of lining presented two known facts: (1)

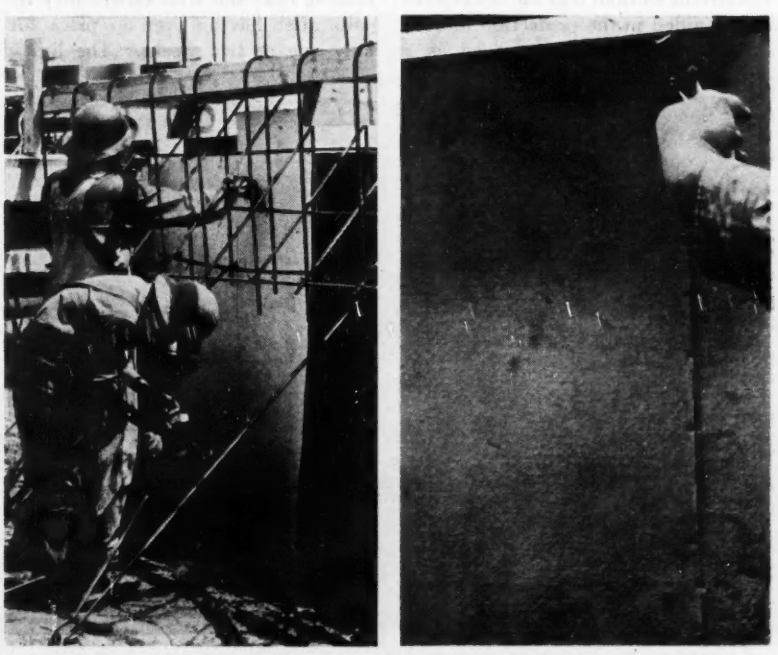


Fig. 3. Absorptive lining is fastened to the forms with stapling machines.

Fig. 4. Inside and outside of panel forms on mass concrete section. Absorptive lining is torn in strips immediately after form is raised to facilitate complete removal when form is raised again.

that removal of the lining became increasingly difficult with length of time left in place; and (2) that there was a possibility of the staples rusting and causing discoloration of the concrete surface after they had been in contact with the concrete for about two weeks.

Liner aids curing

During the first winter of operations at the dam, difficulties in the curing and protection of concrete surfaces were caused by extremely cold weather. An investigation of these conditions showed that the absorptive lining aided in the protection of concrete surfaces and also served as a curing medium. During periods when the temperature was below 35 deg. F. the application of water for curing was discontinued, and the lining retained in place during the full curing period of 21 days between Nov. 15 and April 1, as a curing and protective measure.

During the summer months the lining was, in general, left in place for the full curing period or longer because of a manpower shortage. The longer the lining remained in place, the more difficult its removal became but it could be removed with relative ease and with satisfactory results after having been in place for only one or two weeks. The lining was particularly difficult to remove if it remained in place for any length of time in excess of the curing period and was allowed to dry.

However, it was found that if the lining had been allowed to dry, the difficulty of its removal was lessened slightly by thoroughly saturating it prior to removal. In one small area the lining remained in place for more than two years and sandblasting was found necessary to effect its removal.

The general procedure in the removal of the lining consisted of pulling out the lower corner of a sheet, nicking the lower edge with a knife at a point from 3 to 6 in. from the corner, and tearing a strip of corresponding width for the full length of the sheet. This was done progressively across a lift until all lining was removed.

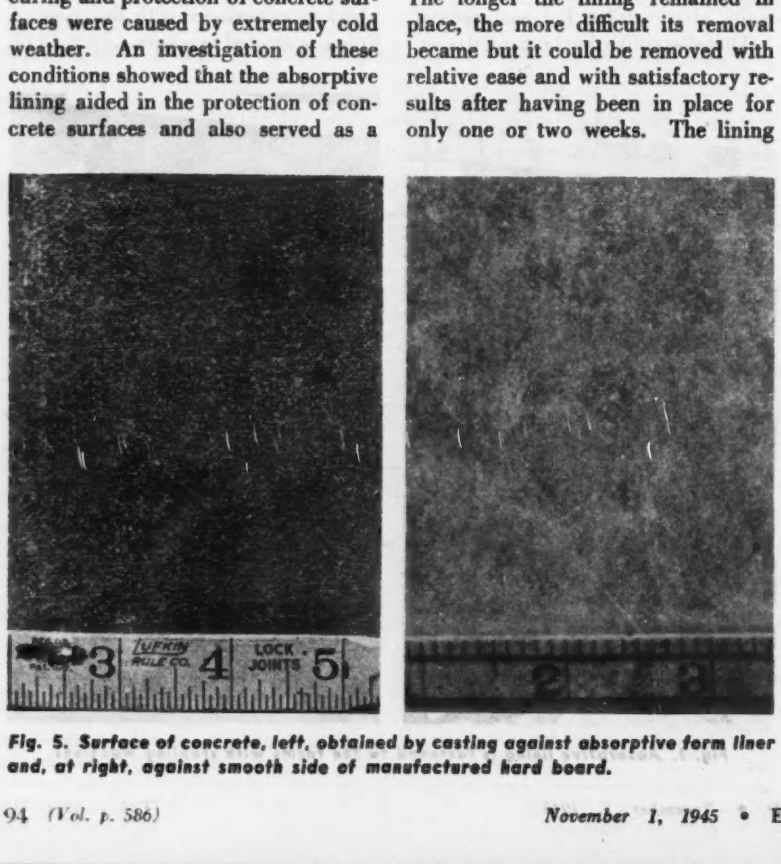


Fig. 5. Surface of concrete, left, obtained by casting against absorptive form liner and, at right, against smooth side of manufactured hard board.

Shortages caused difficulties

The absorptive form lining used at Norfork Dam produced over-all good results despite some difficulties due to use of substitutes in its manufacture. The primary change was use of a synthetic resin adhesive for the rubber latex originally employed to bond the fabric and absorptive backing. Also, the fabric facing of the modified product was of a coarser weave, and the backing appeared to have a coarser fiber than in the original product.

The "ersatz" product was found to be inferior to that used at first and difficulties were encountered in using it that ordinarily would not have been experienced. Chief

difficulty was the separation of the fabric facing and the absorptive backing during both the installation and the removal of the material. The manufacturer later improved the effectiveness of the resin adhesive, and field tests indicated that this improvement resulted in a lessening of the tendency for the facing and backing to separate.

Defects caused by carelessness

Although some defects in the concrete surfaces have been observed, these have been due mainly to such factors as defects in the forms themselves; carelessness in handling, cutting and attaching the lining; vibrating the concrete too close to the form; splattering mortar on the lining and allowing it to dry; use of concrete of too wet consistency; and the placement of concrete at a slow rate of rise in the forms.

The lining was effective in minimizing surface pits and voids; eliminating sand streaking; and in producing an even-textured, dense-appearing surface. The upstream and downstream sloping surfaces, which comprise the majority of the form-lined surface area of the structure, are with few exceptions of excellent appearance.

From experiences with the type of absorptive form lining used at Norfork Dam and elsewhere in the Little Rock Engineer District, it appears that such form lining is more adaptable to massive sections than to thin sections such as parapet walls, towers, and the like.

Data concerning the cost of using absorptive form lining for the construction of Norfork Dam are presented in an accompanying table.

Non-absorptive backing

After a few uses the shiplap or tongue and groove sheathing used for the face of standard panel forms required considerable preparation, such as sandblasting and caulking, to insure satisfactory concrete surfaces. The application of a thin lining, such as ¼-in. thick hard-surfaced manufactured board or plywood, to the sheathing permitted elimination of all dressing and resulted in a considerable labor saving. Fitting this backing to the forms was quickly and easily done and forms so lined could be used several times with a minimum of cleaning after each use.

After attaching the backing to the form, a narrow strip of thin sheet metal was nailed along the top of the backing and the sheathing to prevent grout from entering behind the backing. Any damage to this backing could be quickly and easily repaired. The area requiring the most frequent repair was along the bottom where form rods were placed on 2-ft. centers. When necessary, this damaged section was removed for a width of about 1 ft. and replaced with new material. Prior to attaching the absorptive form lining, the backing was given a light coat of parafine base oil which facilitated cleaning after form removal.

As to the relative merits of the two backing materials used, the hard-surfaced manufactured board proved to be superior. It could be cut to a smooth, clean line, whereas plywood had a tendency to shred in cutting; hence a better job of fitting was accomplished with the former. Also, the thin plywood shrinks and cracks upon wetting and drying.

The staples used in attaching the absorptive lining pull out more easily from plywood, resulting in the staples remaining in the concrete to a greater extent upon form removal. As a backing for absorptive lining, it was found that the manufactured board could be satisfactorily re-used 15 to 20 times whereas plywood was limited to but a few re-uses due to cracking and separation of plies upon becoming wet.

Non-absorptive liners

The same manufactured board was used as a surface lining for all forms in the galleries and chambers in Norfork Dam, the concrete being cast against its smooth side. Under ordinary conditions, the lining could be used five to eight times, cleaning being accomplished by light and fine sanding immediately after stripping. Damaged sections in these forms were replaced with full size sheets to assure a pleasing surface. Upon removal of the forms, the concrete surfaces were washed down, local irregularities or defects were repaired, and all surfaces were sack-rubbed with neat cement.

All forms for the vertical surfaces within the intake structures were lined with plywood except the first (upstream) radial bend where, because of the sharpness of the bend, absorptive form lining was used. Plywood also was used for the forms for the upper portion of the powerhouse walls, these surfaces being subsequently rubbed to produce the architectural effect desired.

Forms for the underneath surfaces of the roadway cantilever on 25 of the monoliths were lined with the manufactured board because of a

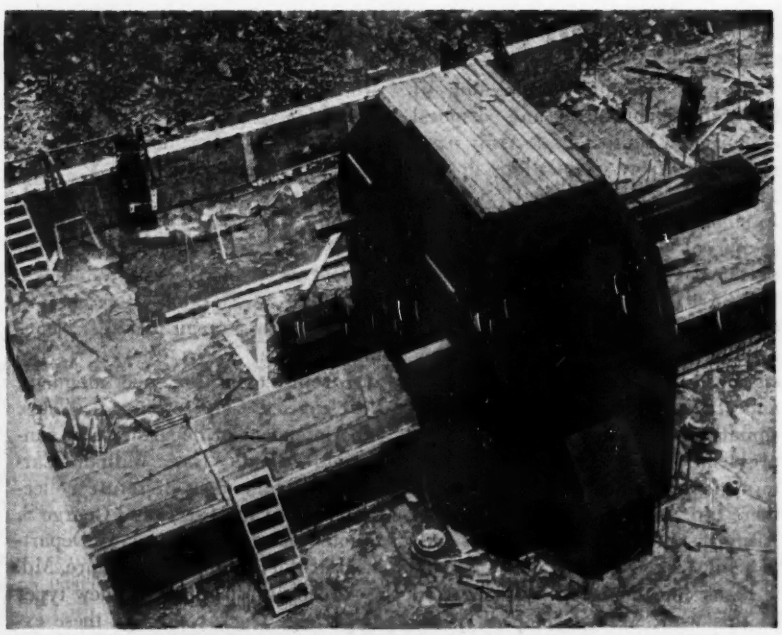


Fig. 6. Forms for interior openings of dam were lined with manufactured hard board and concrete cast against its smooth side.

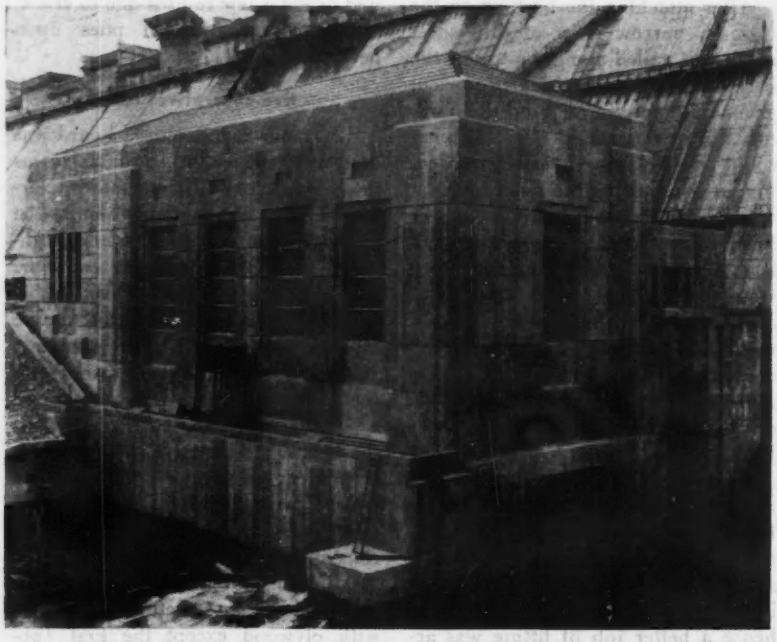


Fig. 7. Concrete for the powerhouse was cast against plywood lining on conventional wood forms and later rubbed to produce the desired architectural effect.

shortage of absorptive lining. It also was used to line all forms for the spillway bridge spans, parapet walls, and the outside walls of the operating towers. For these features, the concrete was cast against the reverse or rough side of the manufactured material. This procedure was followed to provide a surface on the towers that would be more susceptible to rubbing to a desired finish and in order to produce surfaces on the other elements that would resemble closely the surfaces produced by the use of absorptive lining.

Satisfactory concrete surfaces were obtained by placing concrete against plywood and against both the smooth and reverse side of the manufactured board. However, when used on vertical faces such as in galleries, surface voids developed, and sack rubbing was necessary to eliminate the voids and produce the desired surface finish. As could be expected, the bottom surfaces of the spillway bridge spans and roadway cantilevers were practically free from voids. For the purposes for which used, the nonabsorptive liners proved to be very satisfactory.

The most superior concrete surfaces were produced by the use of nonabsorptive lining as a backing for the absorptive material. Such use resulted in a saving of about 3½c. per sq. ft. as compared with the cost of rehabilitating the conventional wood forms for re-use.

Norfork Dam was constructed under the supervision of the Little Rock Engineer District, Corps of Engineers, U. S. Army, by the Utah Construction Co. and the Morrison-Knudsen Co., Inc.

Army to Save $8,000,000 On Refuse Collection

Through further streamlining of the refuse collection and disposal systems and equipment at Army posts and other Army installations in continental United States, the U. S. Army Engineers expect to effect an annual saving of $8,000,000, the War Department reports. The Repairs and Utilities Division, Office of the Chief of Engineers, which operates all Army installations, already has 9 consulting engineers, 6 temporary duty officers and 18 regularly assigned service command engineers at work on the problem. Since the refuse amounts to a ton per thousand men and since there are about 5,000,000 men in Army installations, the disposal work is a big task.

Plans for the better systemization of this work were developed by the Army Engineers at Washington, D. C. Consulting engineers employed on the problem include: Carl Schneider, consulting engineer, New Orleans; Allan Rogers, superintendent of public works, Garden City, N. Y.; William Xanten, superintendent of collection and disposal, Washington, D. C.; Robert Anderson, superintendent of public works, Winnetka, Ill.; John S. Flockhart, engineer in charge of the bureau of street cleaning, Newark, N. J.; George W. Bogart, refuse collection superintendent, Los Angeles, Calif.; Henry J. Cates, superintendent of department of sanitation, Atlanta, Ga.; William Carrigg, superintendent of refuse collection, Sioux City, Iowa; and George S. Elliott, associate engineer of Department of Public Works, Baltimore, Md.

Already in operation are new types of garbage trucks; through these experimental models the Army Engineers will obtain the most efficient equipment of this type. Pick-up stations are being installed at all posts, thus eliminating the unsightly and unsanitary display of garbage cans in front of each barrack as in the past. A dispatch system sends each truck on a pre-determined route and insures a steady flow of refuse at the disposal plants all day long, thus greatly increasing their efficiency.

While the war was in progress, with the consequent manpower shortage, many make-shift methods of refuse disposal had to be temporarily adopted. In one camp it was found that eight different agencies were collecting refuse. The U. S. Army Engineers, in order to avoid leaving rat and mosquito breeding dumps, buried such refuse as could not otherwise be disposed of.

With the reports of the consulting engineers and the special officers in the field to supplement their plans, Repairs and Utilities engineers say they will be able to effect savings of at least $8,000,000 during the coming year.

All but the three highest of Wyoming's many mountain passes are kept open all winter.

AN ENR REPORT

Highway Snow Removal Methods

Snow removal and ice control on state highway systems constitute an expensive public service—one which is taken for granted when it is good, yet quickly criticized when it is not. By virtue of necessity, snow fighting methods of the various states in the snow belt have been steadily improved in recent years, providing greater safety for the traveling public at a reduced cost per mile of maintenance. Brief descriptions of current practices by twelve state highway departments are presented herewith as an aid to those charged with the responsibility of keeping our highways cleared of snow and ice.

IN THEORY, the problems of removing snow from highways might appear to be the same throughout the country; merely starting the plows when the storm begins and keeping them going until the snow quits falling and the highway has been cleared. But such is not the case. Methods of both snow removal and ice control vary widely even in adjacent states in the same latitude.

Each state is faced with its own problems, which include the training of maintenance personnel, selection of the types of snow fighting equipment best suited to the work involved, predicting the intensity and duration of approaching storms, determining which highways must be kept open at all costs and which ones may be permitted to become blocked until the storm is over, or even until the winter season is over.

Then there is the further question of ice

Light trucks equipped with one-way plows and wings carry the brunt of snow removal on Montana highways.

control. What portions of the highways should be sanded, or treated either with chlorides or chemically treated abrasives? Here, the question of improved safety for the traveling public must be weighed against the economics of the cost of preventing icy pavement.

Field experience needed

The erection of snow fence plays an important part in preventing drifts on the highways. Yet each department must decide how large an inventory of fence it can afford to carry, while the field men must determine where to erect the fence so it will be the most effective.

Moreover, the answer to these questions and many others involving wintertime maintenance are not found in books—most of them are learned by the man on the job.

Regarding the different problems confronting the various highway departments in keeping their roads open, Montana experiences occasional heavy snow slides in its mountain passes which are difficult to remove. Wyoming, with its highway system extending over a large area, and a limited inventory of snow fighting equipment, must keep its heavier units highly mobile—dispatching them to the point where they are the most urgently needed.

North Dakota's snow removal problems have been relatively simple the past few winters but spring break-up of oiled gravel highways cause considerable damage when the frost goes out of the subgrade. They have found that building snow traps in freshly fallen snow outside of the right-of-way is a cheaper means of preventing drifting than using long stretches of snow fence.

Minnesota holds a full-dress rehearsal of all snow fighting equipment in advance of the first storm to insure that everything is in readiness. Michigan contracts much of its snow removal to counties, as does Pennsylvania. Maine also contracts much of its snow removal to construction contractors and others. Ice control forms a large part of Michigan's winter maintenance program, with more than twice as much money being spent for the removal of ice from highways in the southern half of the lower peninsula as is spent on snow removal in that area.

Massachusetts spends as much on sanding and other ice control measures as it does on snow removal. Engineers of that state also believe in plowing to the bare pavement, a practice that is not generally followed by other highway departments.

Pennsylvania and Ohio have large mileages of highways to keep open for winter traffic. Ohio maintains over 16,000 miles of roads, while Pennsylvania undertakes complete snow removal on one-half of its 40,680-mile state system, and clears the remainder after the storms have ceased.

TIMING IS IMPORTANT IN MONTANA

Low pressure atmospheric conditions moving south out of Canada cause a great many of Montana's snowstorms to strike without warning. Many years of combating this menace have proved that proper timing, both in reporting anticipated storms and the speed with which snow fighting equipment can be placed in operation following the first appearance of storm conditions, is the key to keeping highways open to traffic.

The state highway department's sectionmen, who invariably are "old timers" with from 8 to 16 years service with the department, together with helpers, working under standing instructions in anticipation of sudden storms, form the front line forces in snow fighting.

With the exception of 67 miles where for various reasons it is not practical to do so, Montana keeps its entire 5,267 miles of state highways

open to traffic throughout the winter. To do this requires the stationing of maintenance crews at strategic points in several of the higher mountain passes. Section houses with buildings for storing snow-removal equipment are maintained at such points as McDonald Pass, Lookout Pass and Bozeman Hill on U.S. Highway 10; at Boulder Hill on U.S. Highway 91; at Kings Hill on U.S. Highway 89 and at several other outlying points. The section houses, located in isolated mountain regions, also serve as emergency shelters for stranded motorists.

The intensity and location of snow storms in Montana are highly unpredictable. They vary from the sharp blizzards with their attendant deep drifts and abnormally low temperatures, which are characteristics of the plateau regions east of the Continental Divide, to the heavy snowfall recorded annually in the western part of the state. Average yearly snowfall at Lookout Pass where U.S. Highway 10 crosses the Montana-Idaho state line measures 400 in. of freshly fallen snow, measured as it lies on the ground before settling.

Equipment inventory

As would be expected in so large a state, the highway department must keep a large inventory of equipment on hand. It includes 154 two-wheel drive, 1½-ton trucks equipped with one-way plows; 42 trucks of the same size for sanding icy roads; 19 four-wheel drive, 1½-ton trucks equipped with V-plows and wings; 48 four-wheel drive, 3½-ton trucks equipped with V-plows and wings; 8 four-wheel drive, 6 to 7½-ton trucks, equipped with auger type rotary snow plows and 3 four-wheel drive, 4 to 5-ton trucks mounted with roto-blade type rotary snow plows. The state also has 24 mechanical sand spreaders for ice control.

The above 173 one and one-half ton trucks, equipped with plows, are assigned to sectionmen for routine snow removal. Those equipped with one-way plows are efficient up to a 6-in. snowfall. The 1½-ton V-type plows, of course, are capable of handling much heavier snow.

The heavier equipment is held in reserve for combating heavier storms. This equipment includes the 48 four-wheel drive units, capable of plowing through drifts up to 4 ft. deep; the roto-type units which are particularly useful in clearing banked snow out of cuts and away from guard rails; and the auger type plows that can cut their way through drifts up to 12-ft. deep. Units of this reserve equipment are assigned to each of the ten maintenance district headquarters and to various section headquarters established upon the summits of the higher mountain passes in western Montana.

Summed up, there is an average of one light snow-plow unit in charge of a sectionman for each 31 miles of highway under winter maintenance; one heavy V-type plow for each 110 miles of such highway; one roto-blade rotary plow for mopping up purposes for each 1,700 miles; and one auger-type rotary plow for emergency reserve for each 650 miles of highway.

During bad weather conditions, and at night, all snow plow units are manned by two operators. Light plows on patrol, or operating during fair weather normally carry but one operator during daylight hours.

Some bad snowslides

Occasional snow slides are encountered in certain areas of western Montana. One such slide buried a section of U.S. Highway 2 beneath 30 ft. of snow and debris. Fortunately, such bad slides are comparatively rare, but when they do occur heavy tractors and bulldozers are needed to open the highway.

Ice control is maintained almost entirely by sanding, using rotary spreaders supplemented by hand shoveling. Winter maintenance costs incurred by the Montana state highway department for the 1944-45 season amounted to $112,600 for snow removal and $54,100 for sanding. This total expenditure of $166,700 represents an average cost of $32 per mile for those highways that are kept open all year.

NORTH DAKOTA BUILDS SNOW TRAPS

Drifting snow rather than excessive precipitation is the chief concern of the North Dakota state highway maintenance crews. Even though the yearly snowfall seldom exceeds 50 in., with much of the state receiving 20 in. or less, the flat terrain and high winds frequently produce drifts that close the highways even during a relatively light storm.

Although a considerable amount of snow fence, both permanent and portable, is used throughout the state many stretches of road become blocked during severe snow storms.

The highway department has developed an inexpensive yet effective method of snow control to supplement that furnished by snow fence. It consists of building what the maintenance men call "snow traps." These traps are merely roughened ridges of

To make certain that everything is in readiness to meet conditions like those shown below, Minnesota's snow removal equipment is given a trial run early in November before the first snowstorms, which come early in that state.

Spring break-up of gravel and bituminous surface roads, due to frost action, is a serious problem in North Dakota's winter highway maintenance.

previously fallen snow made parallel to the highway and located from 50 to 150 ft. outside of the right-of-way.

The traps are formed with whatever motorized equipment is available; light trucks equipped with either V-plows or one-way plows, or light motor graders. Ridges formed in this manner are not over 2 or 3 ft. high but they quickly start building up sizable drifts which help keep the snow off the highway.

The real economy of this method of snow control lies in the fact that one motorized unit can form several miles of traps in a single day. When drifting snow fills a series of traps the process is repeated until the snow gets too deep to afford traction.

Snow removal on North Dakota highways ordinarily does not begin until the wind has subsided. Speed plowing is practiced wherever possible, using 1½ to 3-ton trucks equipped with one-way or V-plows operating up to 25 m.p.h. Such equipment can open short drifts up to 3 ft. deep.

Heavier drifts, up to 6 ft. deep, are opened with large four-wheel-drive trucks mounted with heavy duty V-plows, some of which are equipped with wings on one side. Exceptionally large drifts or those confined in roadway cuts are opened either with rotary equipment or a combination of heavy duty V-plows which open the drifts where possible, followed by rotary plows that throw the snow clear of the road.

One of North Dakota's serious problems of wintertime highway maintenance is the spring break-up of gravel and bituminous surfaced roads. The 1944-45 season was particularly bad in this respect. This unusual condition was caused by two factors. An excessive amount of moisture during the summer and fall of 1944, followed by a light snowfall last winter, caused the frost to penetrate deep beneath the roadway. Also, many of the state's highways are located in flat country and the underlying dense gumbo subsoil provides poor and slow drainage.

Damage by thawing action

When the spring thaws came and the frost went out of the top 12 to 24 in. of roadway, highway traffic created a pumping action which, together with frost boils, softened the subgrade until the surface broke up resulting in several stretches of highway becoming impassible. One such break-up was eight miles long.

Some $300,000 was spent to repair highways damaged by the 1945 spring break-up, while only $75,000 was spent on snow removal for the entire winter. Ordinarily, North Dakota spends about $200,000 per year for snow removal on its 6,650 mi. of state highways.

MASSACHUSETTS PLOWS TO BARE SURFACE

A skid-free pavement surface at all times is the goal of the Massachusetts Department of Public Works in handling snow on highways. In average years about $1,200,000 is spent on 1,850 miles of state highway, about half of which is for sanding and half for plowing. The department supervises road maintenance of an additional 450 miles of town roads on the state system but contributes to the cost of removal under special circumstances.

The state is divided into seven districts and for snow removal is subdivided into sections of about 30 miles each under a foreman. Each of these sections is assigned a pick-up truck, several trucks of about 2-ton capacity equipped with one-way plow and from one to four heavy trucks with one-way or V-plows and wings. The light trucks are the regular maintenance equipment of the state supplemented by hired trucks but plows are supplied for the hired

Patrol grader being utilized in Massachusetts to break up packed snow, which following trucks push off the road.

units. Massachusetts has found that all-wheel drive 8-ton trucks are the best for the large plows needed to move packed windrows and heavy snow. Massachusetts owns 136 such units, which are difficult to rent as they have limited commercial applications.

Work begun at 1 to 2 in. of snow

Trucks are started as soon as the snowfall reaches from 1 to 2 in. in depth. Blades are set to plow right down on the surface to keep the pavement always clear. Plow blades require frequent renewal, but it has been found that if the snow can be bared even in spots it is helpful in preventing skidding, while the sun shining on dark pavement will assist materially in clearing the rest of the surface.

Plows ordinarily operate in echelon; light plows moving at high speed to throw the snow, followed by a heavier unit with wing to push it back from the roadway and avoid leaving sharp vertical faces that encourage drifts. Big plows generally concentrate on drifted or confined areas where light plows cannot operate at high speed. Rotary snow throwers are used to widen banks or open up roads where other equipment has been blocked, especially on other than state highway systems.

Abrasives extensively used

Massachusetts uses from 80,000 to 100,000 cu. yd. of abrasives, mostly sand, treated with from 50 to 100 lb. of chloride per cubic yard in an average year. During the summer, as material is stockpiled, 50 lb. of brine composed of flaked calcium chloride or rock salt is added and when the abrasive is applied, additional chlorides up to 50 lb. per cubic yard may be required. The men prefer working with the dry material when the dry chloride is added, merely intermingling it with the sand as it is passed from hopper to truck.

The use of straight chloride applied with a dispensing device directly to the surface of the highway has been very effective. The chloride is applied over an area about 2 ft. wide at the crown of the road in the form of a continuous ribbon. This method, however, is not used on concrete pavements.

Material for ice control is stockpiled under sheds or covered with waterproof tar and burlap reinforced paper to prevent water getting into it to cause freezing into lumps. Hillside hoppers for the abrasives, where supply trucks can be dumped and spreader trucks loaded, are considered desirable but are not yet available in all areas.

Most of the light trucks carrying the plows have dump bodies and can be used for feeding sand to a trailer spreader. New big trucks purchased by the department have a hopper bottom and a screw feed to a powered spreader that can throw sand over any desirable width.

Snow fence is used in localities where drifting is known to occur.

Snow fighting units, operating in echelon, plow Massachusetts highways to the bare pavement.

MICHIGAN CONTRACTS WITH COUNTIES

Snow removal by contract with county road commissions is proving quite satisfactory in Michigan. Of the state's 83 counties, 59 remove snow and ice from the state highways under actual cost-plus-overhead contracts, while all such work in the other 24 counties is performed by state-owned equipment. Inaugurated a few years ago, this system of contracting wintertime maintenance has grown as rapidly as the different counties could qualify for the work by furnishing proper supervision, maintenance personnel and snow removal equipment.

The state highway department also has entered into contracts with 86 principal cities for the removal of snow and ice from trunkline highways within the city limits. Only a part of the cost of this wintertime maintenance, however, is paid for by the state. The amount of its participation is based on a sliding scale, varying from 80 percent for cities of 20,000 population down to 50 percent for cities of 50,000 or more. In cities of less than 20,000 the state shares the cost in the ratio of the width of trunkline roadway entering the city to the total width of connecting street pavement.

Current practice in Michigan is to remove the snow as it falls, usually plowing to bare pavement except on

More money is spent on ice-control than on snow removal, on many of Michigan's state highways.

Michigan highway is widened by rotary snow thrower, which can also be used to load snow when necessary.

secondary roads. Speed plowing is favored wherever possible. Equipment is pressed into service in the following order as the intensity of snowfall increases: Medium trucks equipped with underbody blades using conventional curved cutting edges for light storms; light trucks with either side-delivery or V-plows; heavy trucks with V-plows for speed plowing; and power equipment for throwing snow clear of the roadway.

Some idea of the magnitude of Michigan's wintertime highway maintenance program can be gained from the amount of state and county equipment required, as shown in the following table:

- 400 dump trucks (3-5 ton) with underbody curved scrapers.
- 500 dump trucks (1½ ton).
- 450 one-way plows for 1½-ton trucks.
- 100 reversible plows for 1½-ton trucks.
- 30 V-plows for 1½-ton trucks.
- 300 heavy duty one-way plows.
- 60 heavy duty reversible plows.
- 200 heavy-duty V-plows (3 ton and over).
- 30 all-wheel-drive trucks (8-10 ton) with V-plows and wings.
- 40 mechanical rotary plows.
- 80 power graders with bank-slicing attachments.
- 600 sand spreaders (tow and motorized types).
- 60 bucket loaders.
- 100 power shovels.

Average yearly snowfall in Michigan runs from 40 in. in the lower peninsula to 230 in. in the upper peninsula. The cost of removing this snow, and ice, from the highways averages $1,000,000 for a mild winter and $1,500,000 for a heavy winter.

Ice-removal is a large factor in Michigan's wintertime maintenance program. Over the southern half of the lower peninsula, 70 percent of winter maintenance is spent on ice control and 30 percent for snow removal. For the upper half of the lower peninsula these costs are about equally divided, while on the upper peninsula, where snowfall is heavier and traffic is lighter, only 30 percent is spent for ice control, 60 percent is spent for snow removal and 10 percent for snow fence. Present trend in ice control is toward a more widespread use of chemicals rather than the application of sand or cinders. Calcium chloride is applied to concrete pavement only when mixed with an abrasive, while sodium chloride is never used on concrete either with or without abrasives.

Of unusual interest is the manner in which winter maintenance crews operate, particularly in regions of heavy snowfall, to provide continuous 24-hr. maintenance when necessary. The regular maintenance employees in each district are divided into two crews, augmented with extra help as needed. At the start of the storm season these crews report on alternate days and continue doing so until near the end of each pay period when they work daily, if necessary, on routine maintenance to fulfill a normal pay period. Under this arrangement, during heavy snowstorms, they are in a position to work alternate 12-hr. shifts.

DISTANCE IS A FACTOR IN WYOMING

Unlike the more densely populated states where each maintenance district has sufficient snow removal equipment to cope with most emergencies, the Wyoming state highway department keeps only enough equipment in each of its five maintenance districts to handle ordinary snowstorms. The state's 4,100-mile highway system is spread over such a large area that any other method of wintertime maintenance would be economically unjustified.

Accordingly, it is not uncommon to transport some of the heavier snow removal units long distances to help open a snowbound highway.

An example of this occurred last April 15 when 39 in. of snow fell in the eastern part of the state within a period of 48 hours. Accompanying high winds completely blocked some 300 miles of state highways. Sixteen heavy units including rotary plows and heavy duty trucks equipped with V-plows and wings were brought in from other maintenance districts to fight this storm, which centered around Casper, Wyo.

Some idea of the distances involved

can be gained from the mileage between Casper and the home bases of the different units. One rotary plow was brought in from Rock Springs, 230 miles southwest of Casper; two units came from Sheridan, 160 miles to the north; five traveled from Rawlins, a distance of 120 miles, while five came from Laramie and three from Cheyenne, each located 190 miles from Casper.

Wyoming's chief concern in wintertime maintenance is to keep as much of its highway system as possible open to traffic, and to rescue motorists who get caught in a sudden blizzard and become marooned in the sparsely settled areas. State highway patrol cars equipped with two-way radios are an invaluable aid in the latter service.

No attempts are made to keep snow from blocking entrances to Yellowstone National Park and three of Wyoming's mountain passes, two of which cross the Big Horn Mountains on U.S. Highways 14 and 16. The other, U.S. 287, crosses the Rocky Mountains through Togwatee Pass at elevation 9,660 ft. Ordinarily these highways are opened by June 1.

Snow plowing on Wyoming's highways usually does not begin until from 3 to 4 in. of snow has fallen. Blades are set about $\frac{1}{2}$ in. above the pavement. Plowing to bare pavement is not considered necessary since the arid climate, high altitude, winter winds and black-top or oiled-gravel highways all contribute to the speedy melting and evaporation of the thin covering of snow left after plowing.

Like many other highway departments, Wyoming has been faced with its problem of snow removal with equipment which is fast growing obsolete. Of the department's 37 motor graders, now in use, 8 are considered worn out. Sixty of the department's 105 one and one-half ton trucks need replacing. Twenty four of the department's 43 two-ton and larger trucks used in winter-time maintenance have served beyond their economical life and need replacing. And out of 34 four-wheel-drive, 4 and 5-ton trucks assigned to the maintenance department, 11 are practically worn out. These, like the other equipment on the verge of obsolescence, however, are kept in sufficient repair to perform their part of snow removal.

Although ice conditions are not very severe in Wyoming, a certain amount of ice control is practiced, particularly on dangerous curves and at the entrance to cities. Calcium chloride is favored for this work (Wyoming has no concrete highways), and slacked coal is used extensively on highways located in the coal mining districts. This slacked coal keys into the ice and helps to make it skid proof. Also, the blackened surface absorbs the sun's rays thus speeding the melting process.

NEW YORK TO USE MORE ABRASIVES

Sanding of icy pavements on New York state highways has been practiced generally throughout the state. In the past it has been confined chiefly to grades and curves but present plans are to cover a greater percentage of the highway system, with a view toward eventually sanding all of the state's icy pavements.

Abrasives used are sand, cinders, slag and fine sizes of stone, a large proportion of which are treated with chlorides. Application of the abrasives has been largely by means of mechanical spreaders, mostly of the rotating-disk type. Storage bins with gravity truck loading are available to a limited extent, but a large proportion of the abrasives are loaded by conveyor from stockpiles previously placed at strategic points along the roads. Chlorides, both sodium and calcium, are handled largely in paper bags. The expansion of bulk handling of chlorides is possible in New York State since both calcium and sodium chlorides are manufactured within the state at locations convenient for direct truck haul to a considerable mileage of highway.

Application of straight salt without abrasives has been practiced more or less experimentally, using engine-operated salt sprayers, together with gravity chutes, both giving evidence of satisfactory performance.

V-plow with wing on a patrol grader clears a high level Wyominng road near the Salt River Mountains.

Highways in the New York state system comprising about 12,800 miles, are cleared of snow by the several counties under agreement with the state's Department of Public Works. Sanding and ice control are performed jointly by the state and county forces.

During the past five years the cost of snow removal per mile has varied from an average of $87 to $193, while the cost of sanding has varied from $87 to $121 per mile; the higher figure for both operations being for the unusually severe winter of 1944-45.

The state reimburses the counties for snow removal on the state highway system on a basis of 50 percent of the cost of the work, but not to exceed $75 per mile of highway cleared. On county and town highways the work is performed and the cost borne by the county or municipality.

In a large number of the counties the actual work of plowing is done in part at least by the towns on both the state and county systems, as well as on town-owned highways. This procedure makes it possible for towns and counties to own and operate larger and more expensive equipment than would have been possible had their work been restricted to their own highways.

SNOW COMES EARLY IN MINNESOTA

Some of Minnesota's heaviest snowfalls are apt to occur early in November. Motorists invariably get caught by these early onslaughts of winter, but not the state highway maintenance crews who believe in being fully prepared for such contingencies. To start this program of preparedness, a date is selected each fall by the state highway maintenance engineer as being that of the first possible blizzard. Usually the date is set for some time during the first week in November, and all snow removal equipment must be ready to go into action at once at that time.

Such a plan has several merits. Trial runs of fully equipped motorized units, made prior to this established date, not only insure everything is in readiness for a storm, but they also serve to refresh the memory of each operator regarding the mounting and operation of the different snow plowing attachments. Then too, it guards against last minute delays due to the lack of some small but vitally needed accessory. Following the trial runs, snow plowing attachments may be dismounted if they interfere with routine maintenance operations. When this occurs each operator is charged with the responsibility of storing his equipment in some convenient location ready for instant use wherever it is necessary.

Sixteen maintenance districts

It is not so much the amount of the snowfall or severity of the storm that blocks Minnesota's highways as it is the failure of motorists and truckers to heed storm warnings. In spite of newspaper and radio weather reports, each severe storm catches many vehicles trying to complete their schedules. This often results in several cars and trucks becoming stalled along the highway, which adds to the general tie-up of traffic.

Minnesota is divided into 16 maintenance districts under which operate section crews who maintain from 25 to 50 miles of highway. Most of the snow plowing is performed with light trucks equipped with either one-way or V-plows with heavier equipment and rotary plows being used as necessary in severe storms. Many of the trucks are equipped with wings, particularly those of the heavier types. Until recent years V-plows were used to a major extent, but the present trend is toward the use of one-way plows as much as possible.

Although the removal of snow

Patrol grader with plow and wing clears a road near Gore Pass, high in the Colorado Rockies.

from the state highways necessarily is of primary importance, much attention is given to ice control. Sodium chloride and calcium chloride are used on asphalt pavements but not on concrete. Except in metropolitan areas, sanding and other ice-control measures are restricted to dangerous intersections and other hazardous points along the highways.

Current practice in sanding highways in metropolitan areas carrying heavy traffic is to hand-shovel the sand from trucks into ridges across the roadway at about 10-ft. intervals. Applying the sand in a thin film over the highway by a rotary spreader is not favored as it soon is whipped off the pavement under traffic. Calcium chloride or common salt, when used, are applied along the centerline.

The Minnesota state highway department ordinarily does not remove snow from county or township roads. Neither does it remove snow from city streets except those that come under the jurisdiction of the department. In the latter case, the work usually is performed by the city under a contract with the highway department.

Snow removal on Minnesota's state highway system during the winter of 1944-45 cost about $521,000, of which $228,000 was spent for the erection, maintenance and dismantling of the state's 5,000,000 lin. ft. of portable snow fence.

OHIO FAVORS PATROL SYSTEM

Winter maintenance crews located at strategic points and operating under a patrol system have proved much more effective in combatting snow and ice on Ohio highways than any previous method. Under this system the crews stationed at outlying districts are much nearer the job and thus are able to have the adverse conditions under control much quicker than where it is necessary to travel from some central point.

Each crew is held responsible for the proper control of snow or ice on from 20 to 30 miles of highway. They are equipped with a truck, snowplow, necessary small tools and a spinner-type distributor to spread abrasive and chlorides on the icy pavement.

Special lights for equipment

Ohio has adopted a special system of lighting its snow fighting equipment, unlike anything on the highway. It includes an alternating flasher light on each side of the truck cab showing blue to the front and red to the rear. The idea was to devise a system of lighting different from that used on commercial trucks so that the motorist could immediately identify it as a state highway truck in operation.

Public warned 3 times daily

During winter weather the traveling public is informed three times daily as to the condition of Ohio's highways. These road reports are originated by the outlying patrols who report them to the highway superintendent at the county garage. The information is passed on to division headquarters of the highway department, which in turn relays it to the state highway patrol radio station. From there it is passed on to various agencies such as newspapers, local radio stations, bus and trucking companies, etc. The highway patrol radio station also broadcasts the reports three times daily.

During the winter of 1943-44 snow removal operations covered 16,100 miles of state highways in Ohio. Also a total of 617,500 lin. ft. of snow fence was used in attempting the control of drifting snow in the northern half of the state. No fence is used in the southern half of the state since drifting is not a serious problem in this section.

State highway snow removal equipment today includes 1,030 trucks

Plows are most efficient when they operate fast enough to throw the snow rather than push it.

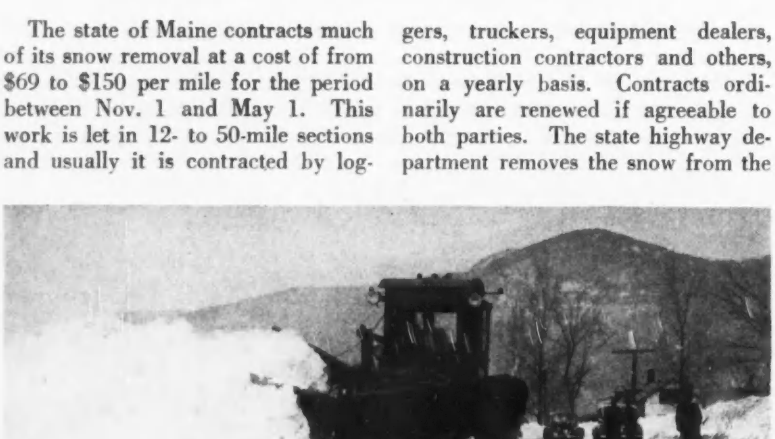
Even sunny California has to fight snow, as shown by these snow throwers opening a road through a mountain pass.

equipped with 740 plows. In comparison, only 280 snowplows of all types were used in 1930. The state also uses about 800 spreaders of various types in distributing chlorides and abrasives.

MAINE CONTRACTS FOR REMOVAL

The state of Maine contracts much of its snow removal at a cost of from $69 to $150 per mile for the period between Nov. 1 and May 1. This work is let in 12- to 50-mile sections and usually it is contracted by loggers, truckers, equipment dealers, construction contractors and others, on a yearly basis. Contracts ordinarily are renewed if agreeable to both parties. The state highway department removes the snow from the more heavily traveled highways, especially in the northern part of the state. Practically all the equipment used is plows, many with wings, attached to trucks. The state has one rotary plow in the Aroostook area where drifting over cleared land is severe.

During the winter of 1943-44 the state highway department cleared 2,816 miles of state highways and participated financially (paid all over $35 per mile in small towns having a valuation of less than $200,000, $50 per mile in larger towns) on an additional 5,239 miles of state-aid highways and 6,400 miles of "town-ways." The state provides supervision for the latter two classifications but the towns make contracts direct for the clearing.



State-owned equipment used for removing snow from Maine's highways consist chiefly of V-plows mounted on trucks. Some units also have wings.

Work starts at 2 to 3 in. of snow

Contracts require that plowing start when snow reaches a depth of 2 to 3 in. and continue until all is pushed off the shoulders. The state agrees to furnish and maintain a specified number of feet of snow fence. In addition, the state does a large amount of sanding for skid prevention and maintains a few big trucks for emergency aid throughout the state.

A diesel motor grader equipped with V-type plow is used to clear a county road in Idaho.

Average cost per mile of clearing state highways in 1943-44 was $264; for state-aid and "town-way" highways $92; while for the entire system, 14,454 miles, the cost was $125 per mile.

VERMONT PREFERS PREVENTION

The Vermont Department of Highways is building its new roads higher across open stretches, and in some cases is cutting down knolls in adjacent fields to eliminate snow traps. Snow fences are used extensively—frequently "double-decked" as snow piles high enough to make the first one useless. Occasionally fences are used in series on the ground.

One man handles each area

For snow removal, Vermont is divided into 12 districts, each of which is subdivided again into areas that one man can handle. Equipment regularly assigned to each small area is a 1½ to 2-ton truck with one-way blade plow. About three-fourths of the light trucks are hired, with drivers, on an hourly basis, but in most cases the state owns the plow. Formerly, heavier equipment was used, but light plows operating at high speeds have been found to give better results.

Plowing starts with the storm and every effort is made to prevent any considerable accumulation of snow on the roadway. Heavy equipment such as all-wheel-drive trucks with V-plows and wings, is held in reserve at the district headquarters. When patrolmen report inability to keep up with the storm or the necessity for heavy equipment to push back accumulated windrows, the heavy machines are dispatched from the district offices. This heavy equipment is temporarily shifted between districts also to aid in meeting severe storms.

On mountain roads where speed for throw cannot be attained, patrol

All-wheel-drive truck with plow and wing widens New Hampshire road despite established high bank.

type machines are used to push V-plows and wings. In towns, tractors with V-plows frequently are used to push rather than throw the snow.

Chlorides, both sodium and calcium, are used extensively on Vermont roads, of which only a small mileage is concrete. Usual procedure is to distribute chloride along a strip down the center of the road as the temperature is falling. This keeps the snow softened at the center so it is broken up by traffic and can be pushed off the road. Heat absorbed by the black top pavement, as center areas are exposed, helps to clear the snow progressively across the roadway.

On all roads sand and cinders treated with calcium chloride or sodium chlorides are used to prevent skidding.

NEW HAMPSHIRE'S COSTS ARE LOW

All snow handling on highways in New Hampshire under the supervision of the state highway department is done with the state's own forces, using light plows first and, as the snow accumulates, heavier plows and wings. Plowing starts when snow has reached a depth of 3 in. and continues until all snowfall and drifting are over and the highways are opened to traffic.

For the past four years, sodium chloride has been used as a de-icing agent and to remove snow not picked up by the plows. A ribbon of salt, about 20 in. wide is spread down the center of the highway. This loosens the ice and compacted snow and gives a bare area along the center where drivers on each side can keep the inside wheels, thus avoiding skidding.

Application of the salt costs about $3.50 per mile per application. Snow clearing costs about $1.25 per mile per inch of snow in an average winter season.

PENNSYLVANIA USES MUCH POWER

In Pennsylvania, it has been found necessary to use powerful and fast-moving trucks for snow removal. Plowing starts when the snow has reached a depth of 1 in. and continues until the roads are clear.

Light trucks, equipped with blade plows, are used at the start of a snowstorm, but they are replaced with heavier units if the snowfall is heavy or if excessive drifting occurs. These larger units are equipped with plow frames and blade plows. Rotary or V-plows can be attached to them when required, thus adequate motor power is always available for the type of plow that is needed. For extraordinary drifting, tractors with V-plows are used to a good advantage, as are rotaries and tractors equipped with angledozers.

Rural roads opened last

Wintertime maintenance of Pennsylvania highways is unusual from the standpoint of the total mileage involved. The highway department undertakes complete snow removal and ice control on 20,170 miles of the 40,680-mile state highway system. The remaining 20,510 miles, consisting chiefly of rural roads, are opened after the storms have ceased and the primary routes are in first-class condition.

Pennsylvania places 2,530 miles of snow fence each year and, in addition, has about 25 miles of natural evergreen snow breaks. Some 300,000 tons of abrasives, such as sand and cinders, are placed on the highways each winter. Most ice control by the department is limited to steep hills, sharp curves and highway intersections.

Ice and snow removal cost

During an average winter, Pennsylvania spends from $3,000,000 to $4,000,000 for snow removal and ice control. Over $7,300,000, however, was spent for this work last winter due to the abnormal conditions encountered from December to March. This was the greatest wintertime maintenance cost in the history of the department.

Best results in removing snow from New Hampshire's highways are obtained by trucks, equipped with one-way blades, traveling at a speed of 15 mph.

A coat of coal tar and a spiral wrapping of asbestos-felt was applied following the cleaning and priming "caravan."

Natural Gas Pipeline 90 Miles Long Has Long Unsupported Spans

***Contents in Brief**—A welded steel pipeline, 16 and 18 in. in diameter, recently built from oil fields near Santa Barbara to Los Angeles transmits natural gas in either direction under pressure of 1,000 psi. Some of the novelties in the construction project were equipment for cleaning, tar-coating and wrapping the pipe in the field after welding, unsupported spans up to 420 ft. long across canyons, and a narrow sheepsfoot roller built to compact trench backfill.*

INCREASED DEMAND for natural gas in war industries of southern California led to construction recently of a 90-mi. pipeline 16 and 18 in. in diameter from the La Goleta oil fields north of Santa Barbara to Los Angeles. The section of the line from Santa Barbara to Ventura is designed for gas pressure of 1,000 psi. and is to transmit the gas in either direction. In summer, which is off peak season for gas heating, surplus gas that is a byproduct from oil fields where no storage is available will be pumped to La Goleta to be held in natural underground storage basins. This "repressured" underground storage (as oil field operators call it) will be the source of a supply that will flow back through the new pipeline to meet the peak load of winter, largely resultant from heating demand. Construction of the pipeline, which cost about $3,900,000 and has a capacity of 165,000,000 cu. ft. per day, was the incentive for developing equipment and methods that extend or improve upon those previously used.

Various methods of construction were used on different parts of the line because it had to be built through thickly populated areas as well as across undeveloped, rough mountain regions. In the latter it was the rule to clear and grade the 30-ft. right-of-way so that construction equipment could move readily along the entire route. In many sections access roads also had to be built, generally just a rough grading job done by bulldozer. In the steep, mountainous terrain along the ocean shore, canyons often had to be crossed where no bridge structures were available.

The pipe was delivered along the right-of-way in 40-ft. lengths of diameters and thicknesses shown in the accompanying table. To expedite construction of the line, crews were organized for each of several specialty operations, with a view to allocating to each crew manpower and equipment sufficient for the schedule that was set up as bogey to coordinate work on the project as a whole. This made it necessary to use equipment that would "walk" along the pipeline, performing—while in motion—an operation usually associated with the factory production.

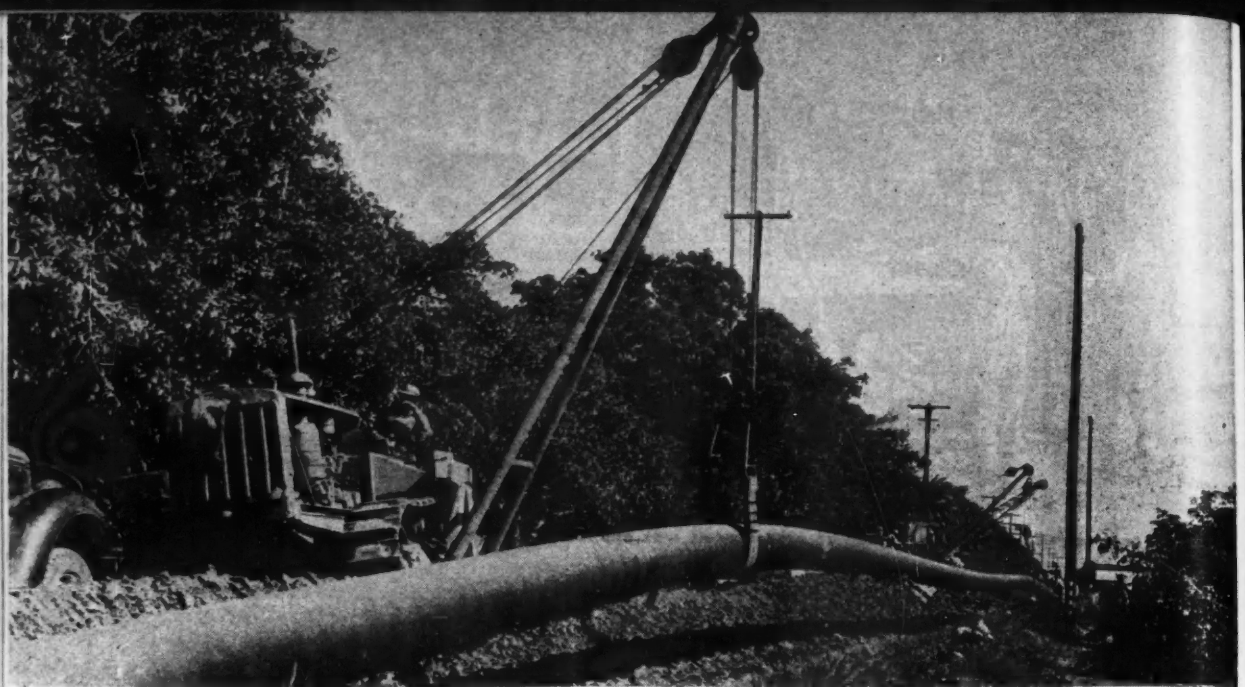
SECTIONS OF THE LaGOLETA-LOS ANGELES PIPELINE

Length (mi.)	Diameter (in.)	Thickness (in.)	Weight (lb./ft.)
19.75	18	5/16	59.03
34.25	18	¼	47.39
12	16	11/32	57.478
23	16	5/16	52.357
2	14	⅝	89.279

Caravans of equipment

A tractor with a side boom was used to line up sections along the right-of-way for the first welding crew, which did a tack-welding job. That is, this crew laid a single stringer bead around each joint. The crew following did the major portion of the welding, applying two or three additional beads, as required.

With the pipeline welded into long continuous sections it was ready for what the contractors called "caravans" of specialized equipment that moved along the line working on or treating it successively. The first operation was cleaning with power-driven wire brushes and cutters that removed scale and rust from the entire exterior surface. This and the priming operation were done with one machine. After a lapse of time sufficient for the priming to dry



Lowering an 18-in. section of the line into the trench. In this operation tractors worked in pairs about 100 ft. apart.

thoroughly a layer of coal-tar enamel was applied hot and then immediately two spiral layers, wound in opposite directions, of asbestos-felt protective coating were placed over the pipe. The usual high potential spark test was used to locate any flaws in the coatings.

Pipe laying operations

The intent was to have the pipeline as a whole under 30-in. of earth cover. Accordingly, trenching machines cut the ditch to an average depth of 4 ft. The usual width was 28 in. When the pipe was ready, tractors with side-mounted cranes, usually working in pairs about 100 ft. apart, lifted the pipe and lowered it into the trench.

Backfilling was done with bulldozers or bladers. In locations where the trench closely paralleled a highway the backfill had to be compacted to meet the state highway requirements, which stipulated that on road shoulders bearing value of the backfill must correspond to subgrade for highway construction. To accomplish this effectively the contractors built a special sheepsfoot roller made the right width to work in the 28-in. trench. It was rigged to be slung from a side-boom on a tractor, which could be moved back and forth along the trench until the desired compaction was attained.

It was found feasible to cross canyons in the mountain sections of the route without cables or other external means of support. This plan was used successfully in a number of crossings, of which the longest has a 420-ft. span. For these spans no anchorage was used other than the embedding of pipe in the trench at either end of the suspended portion. It was found advisable to make bends in the pipe at each bank where the sharpest curvature occurred.

Suspended spans were not put in until after the pipe had been laid up to both edges of the canyon to be crossed. A sufficient number of pipe sections for the crossing were then welded up into one continuous length and pulled across the canyon by means of a cable put up for construction purposes. This cable was kept well above the level at which the pipe would be slung. Thus when the pipe reached the far side it could be allowed to sag down to its final position as the supporting cable was slacked away. In this process of taking its own load the 16-in. pipe assumed a minimum radius of curvature of about 800 ft. After a little experience with these spans it was possible to predict the amount of bending that would be desirable in the approaching portions of the pipe.

"Wrinkle bends" were made with a torch on long unsupported spans to give desired curvature and to relieve bending stress.

Hot wrinkle bends

Bends were made by two methods: (1) cold bending against a shoe with the aid of a winch, a method long used in oil pipeline practice, and (2) the "hot wrinkle" bend process. The former is difficult. The latter was applied with good success. It involved use of a gas torch to heat bands about 7 in. wide extending around three-quarters of the circumference on the lower side of the pipe. Softening of the metals in such a band while the pipe was under bending strain, caused the formation of a wrinkle and gave the pipe slight curvature. These wrinkles were put on at 20-ft. intervals until sufficient curvature had been set in the pipe to

Unsupported spans up to 420 ft. long cross deep canyons. Cable from tower at right was used only during construction.

produce an alignment change that would relieve bending stresses induced by the suspended span.

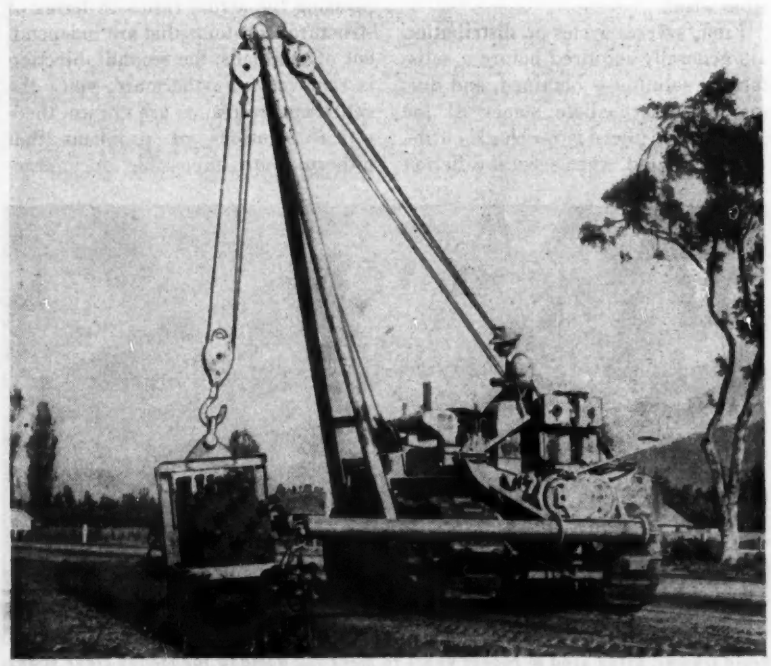
At crossings of the two important rivers, the Santa Clara and the Ventura, because of the floods that occasionally sweep down the lower reaches of these streams, it was considered advisable to put the pipe well below river bed. Accordingly, trenches were dug in which an 8-ft. to 20-ft. cover could be put over the pipe after it had been laid. By laying the pipe in the trench part way across the bed of the river and then diverting stream flow over that portion of the crossing, the crossings were made during the low-water season without difficulty.

Internal cleaning by gas blast

As considerable lengths of the line were ready to be lowered into the trench, the interior surface was given a thorough cleaning by small steel particles driven through the line with a flow of natural gas under pressures of about 400 psi. At the discharge end of each section the steel grits and the material carried out with them in the cleaning process were discharged at a vent. When each section had thus been thoroughly treated in this way and only clean gas was coming through, the section was connected to other portions of the line, ready for service.

When the line was completed convenient lengths were sealed off and subjected to a water pressure test at 1.5 times the designed working pressure. Danger of corrosion on the inner surface of the pipe during operation is minimized by a dehydrating plant at the intake which removes moisture from the gas. To combat external corrosion cathodic protection is provided.

This pipeline was built as a joint project to make the underground storage facilities of the Pacific Lighting Corp. available to the Southern California Gas Co. and the Southern Counties Gas Co. Preliminary engineering work was done under supervision of H. P. George, of the Southern California Gas Co., and Fred A. Hough, of the Southern Counties Gas Co. The principal contract was held by the Pacific Pipeline Construction Co. and the Pacific Crane & Rigging Co., Inc., Los Angeles, who undertook the construction job as a "joint venture."



Sheepsfoot rollers, specially built to trench width and operated from side-arm tractors, gave the compaction required in shoulders of paved highways.

Moment Ratios Simplify Continuity Analysis—Part I

Frederick S. Merritt
Editorial Assistant, Engineering News-Record

***Contents in Brief**—Maximum bending moments in continuous structures may be computed readily by using moment ratios, factors that permit one-cycle moment distribution. Moment ratios evaluate the actual restraint at beam ends and are particularly valuable in problems that occur in everyday practice because they are structural constants, independent of magnitude or location of loads. The technique of using moment ratios in continuity analysis as developed by the author during 10 yr. of practical experience will be explained in two articles. Part I develops the concept and includes an application of moment ratios to the analysis of a continuous building frame. Part II, covering other types of structures, will appear in ENR Nov. 15.*

THE INTRODUCTION of fixed-end moment distribution was a milestone in the progress of indeterminate structural design, primarily because it eliminated the necessity for solving the simultaneous equations required by the slope deflection and least work methods. But although any designer can use it and with the aid of a slide-rule solve continuous beam problems, fixed-end moment distribution is far from ideal.

First, several cycles of distribution are generally required before a satisfactory solution is obtained, and during the intermediate stages of the computation there is no check on the work. Second, when several different conditions of loading on the same structure occur, either influence lines must be plotted or the problem must be re-analyzed for each condition.

Evaluation of the actual end restraint for each span of a monolithic structure removes the first objection by yielding a solution in one cycle. This may be done by using the actual end moment ratios instead of fixed-end moment ratios. Then, by expressing the actual ratios in terms of structural constants that are independent of the loads, the second objection is removed. Furthermore, since the actual end restraints are known, theoretical solutions of problems that hitherto were impossible or impractical by other methods can now be obtained.

This article presents such a method of analysis, designated as the method of moment ratios. Developed by the author during a 10-yr. period of practical design experience with continuous structures, it permits all computations to be made by slide rule just as for fixed-end moment distribution and it uses the usual sign conventions—clockwise end moments and end rotations at a joint are considered positive and counter-clockwise end moments and end rotations negative.

The common practice of plotting moment diagrams on the tension side of members is recommended. Then, arrows curved around a joint in the direction indicated by the sign of the end moment will not only indicate the direction in which the end of the member is concave (Fig. 1, 2 and 3) but also the direction in which the moment ordinate is to be plotted.

To facilitate the use of the method in practice, structural constants for evaluating end restraint are selected with a view toward obtaining a minimum of necessary formulas and to make the formulas as simple as possible. For this purpose the concept of the unit beam is adopted. Furthermore, the use of the unit beam makes it convenient to construct tables of constants for beams of variable moment of inertia, as can be seen from the following discussion. The nomenclature used is summarized in the accompanying table.

Rigid frames, often used in recent years to meet the demand for longer clear spans and greater clear height, may be readily analyzed through the use of moment ratios for bending moment distribution.

Unit beam concept

The action of a beam in a monolithic structure depends upon its shape and size relative to the rest of the structure. In order to determine relative values, each span must be studied under the same conditions of support and loading. The most convenient procedure is to con-

vert each member into a unit beam (Fig. 1), an unloaded, simply-supported span of unit length, unit modulus of elasticity and unit moment of inertia at minimum section. End rotations obtained in the unit beam can be converted into end rotations in the prototype by multiplying by L/EI, where E = modulus of elasticity, generally taken as unity when relative values are involved, I = moment of inertia at minimum section and L = distance between centers of supports.

Three fundamental quantities needed for the analysis of beams having rectilinear neutral axes can be defined with respect to the unit beam. They are α_L, the rotation at the left end of the unit beam due to a unit moment applied at that end; α_R, the rotation at the right end due to a unit moment applied there; and β, the rotation at one end due to a unit moment applied at the other end. By means of the Dummy Unit Load Method, it can be shown that

$$\alpha_L = \int_0^1 \frac{(1-x)^2}{I_x}\,dx;\ \alpha_R = \int_0^1 \frac{x^2}{I_x}\,dx;$$

$$\beta = \int_0^1 \frac{x\,(1-x)}{I_x}\,dx,$$

where I_x is the moment of inertia of a section at a distance x from the left support of the unit beam. For beams of constant I, $\alpha = 2/6$ and $\beta = 1/6$.

It will be found convenient to represent $EI/\beta L$ by K. Therefore, for beams of constant I, $K = 6EI/L$. Unless actual end rotations or deflections are required, only relative K-values are needed and, therefore, for spans of constant I the factor 6 may be ignored.

Stiffness of beam defined

Using these fundamental terms, the structural properties of the prototype as a member of a monolithic structure can be evaluated. For example, the *stiffness* S of the end of an unloaded span is defined as the moment producing a rotation of unity at the end where it is applied when the other end of the beam is restrained against rotation by other members of the structure. Referring to Fig. 2,

$$S_{OA} = \frac{M_{OA}}{\theta_{OA}},$$

where S_{OA} is the stiffness of member OA at end O, and M_{OA} is the end moment at O in OA producing θ_{OA}, the end rotation at O in OA.

The moment ratio C is defined for an unloaded member of a continuous structure as the ratio of the moment introduced at one end of the span to the moment carried-over, or transmitted, to the other end. In Fig. 3,

$$C_L = \frac{M_R}{M_L}.$$

Stiffness can be computed in terms of K and C. Referring again to Fig. 3,

$$\theta_R = \frac{M_R}{S_R} = \left(M_R\alpha_R - \frac{M_R\beta}{C_L}\right)\frac{L}{EI}.$$

(Note the manner in which θ_R is built up in terms of α_R and β). Therefore,

$$S_R = \frac{K}{\alpha_R/\beta - 1/C_L}.$$

Similarly,

$$S_L = \frac{K}{\alpha_L/\beta - 1/C_R}.$$

For beams of constant moment of inertia,

$$S_R = \frac{K}{2 - 1/C_L};\ S_L = \frac{K}{2 - 1/C_R}.$$

Restraint at beam end defined

The *restraint* R at the end of an unloaded beam at a joint is defined as the moment applied at that end to produce a unit rotation in all the members of the joint. Referring to Fig. 2,

$$R_{OA} = \frac{M_{OA}}{\theta_{OA}}.$$

where R_{OA} = the restraint of member OA at O.

Then, since $M_{OA} = M_{OB} + M_{OC} + M_{OD}$, $\theta_O R_{OA} = \theta_{OB}S_{OB} + \theta_{OC}S_{OC} + \theta_{OD}S_{OD}$. But, by definition of continuity $\theta_O = \theta_{OB} = \theta_{OC} = \theta_{OD}$. Therefore, $R_{OA} = S_{OB} + S_{OC} + S_{OD}$.

According to this last equation, the restraint, by definition of continuity, is equal to the sum of the stiffnesses of the adjacent ends of the other members at the joint. Furthermore, the moment induced in any of these other members bears the same ratio to the applied moment as the stiffness of the member does to the restraint. Consequently, *end moments are distributed at a joint in proportion to the stiffnesses of the members.*

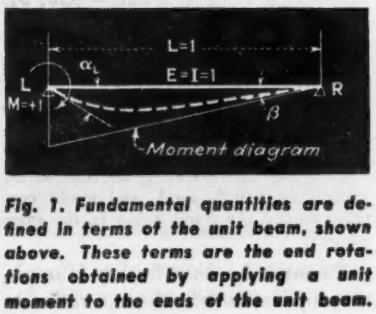


Fig. 1. Fundamental quantities are defined in terms of the unit beam, shown above. These terms are the end rotations obtained by applying a unit moment to the ends of the unit beam.

Moment ratio evaluated

Moment ratios can be computed in terms of K and, through R, the moment ratios of preceding spans. Referring to Fig. 3,

$$\theta_L = -\frac{M_R}{C_L R_L} = \left(\frac{M_R\alpha_L}{C_L} - M_R\beta\right)\frac{L}{EI}.$$

Therefore,

$$C_L = \frac{\alpha_L}{\beta} + \frac{K}{R_L}.$$

Similarly, the moment ratio to the right is

$$C_R = \frac{\alpha_R}{\beta} + \frac{K}{R_R}.$$

Toward hinged supports, for which $R = 0$, C is infinitely large; toward fixed ends, for which R is infinitely

SUMMARY OF NOTATION

- α = the rotation at one end of the unit beam due to a unit moment applied at that end.
- β = the rotation at one end of the unit beam due to a unit moment applied at the other end.
- γ = a constant representing the effect of restraint approximately.
- θ = end rotation.
- ϕ = simple beam end rotation due to loads on a span.
- a = distance of load from left support for unit span length.
- b = distance of a load from the center of gravity of the load mass.
- d = sidesway of a support.
- f = fixity.
- A = function of end rotation.
- C = moment ratio.
- C' = moment ratio based on final end moments.
- D = distribution ratio.
- E = modulus of elasticity.
- F = fixed-end condition (used as super-script).
- G^2 = the square of the radius of gyration of a load mass.
- I = least moment of inertia.
- K = $EI/\beta L$.
- L = span length.
- M = end moment.
- P = concentrated load.
- S = stiffness of an unloaded beam.
- S^3 = a third order moment summation of loads about the center of gravity of the load mass with respect to the total load.
- W = total load on a span.

large, $C = C' = \alpha/\beta$. For prismatic beams $C' = 2$. Thus for beams of constant moment of inertia,

$$C_L = 2 + \frac{K}{K_L}; C_R = 2 + \frac{K}{K_R}.$$

To give a physical picture to the concept of moment ratios, the term fixity, defined by the ratio C'/C, is introduced. Obviously, fixity varies from zero for simple supports to 100 percent for fixed supports. Referring to Fig. 3, let Θ_F = the rotation of a beam at a hinged support and Θ = the rotation when restraint is present. Then,

$$\frac{\theta}{\theta_F} = \frac{-M\beta + M\alpha/C}{-M\beta}$$
$$= 1 - \alpha/\beta C = 1 - C'/C.$$

Therefore, fixity is also equal to $1 - \Theta/\Theta_F$ and, consequently, is a straight line function of the angular rotation. For example, if a column footing rotates about 0.2 as much as it would if it were unrestrained by the soil, the fixity is 1 — 0.2 or 0.8 and, assuming $C' = 2$, the moment ratio for the column in the direction of the footing may be taken as 2/0.8, or 2.5.

In analyzing a continuous beam the moment ratios toward the ends of the first and last spans are generally known. Starting with these values, the rest of the moment ratios for the structure may be calculated. However, in many frames there are no end conditions known in advance. To analyze these structures several of the ratios must be assumed.

This will not complicate the analysis, because in many cases it will be found unnecessary to correct the values of C based on assumed ratios of preceding spans, for C is not very sensitive to the restraint at far ends of adjacent members. In fact, as will be demonstrated later, use of approximate C-values will be found convenient in certain types of problems. The greatest accuracy will be attained if the choice of assumed values is restricted to members subject to the greatest restraint.

Ratio may be estimated

A very good approximation to the moment ratio for prismatic beams may be obtained from the following formula, which is based on the assumption that the far ends of adjacent members are subject to equal restraint:

$$C = 2 + \frac{\gamma K_1}{\Sigma K},$$

where K_1 is the K-value of the member whose C is to be assumed, ΣK is the sum of the K-values of the other members of the joint toward which the ratio is directed, and γ is a constant varying from 1.5 for full restraint to 2.0 for no restraint at far ends of these other members. Since γ varies between such small limits, it affects C very little.

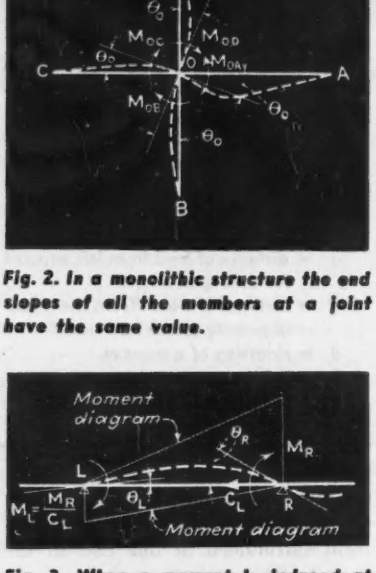


Fig. 2. In a monolithic structure the end slopes of all the members at a joint have the same value.

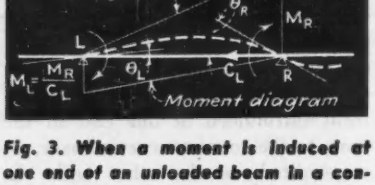


Fig. 3. When a moment is induced at one end of an unloaded beam in a continuous structure, the moment is carried over to the other end in a fixed ratio.

Example 1—To illustrate the method of calculating C and the effect of an adjacent span, the moment ratios in the clockwise direction for the frame shown in Fig. 4 will be computed. A start will be made by assuming C_{AB}. Approximately, taking $\gamma = 1.75$, $C_{AB} = 2 + 1.75 \times 3/2 = 4.62$. Using the formula for stiffness, $S_{AB} = 3/(2 - 1/4.62) = 1.68$. Since AB is the only restraining member of AD at joint A, $R_{AD} = S_{AB}$. Using the exact equation for moment ratios, $C_{DA} = 2 + 6/1.68 = 5.57$; $S_{DA} = R_{DC} = 6/(2 - 1/5.57) = 3.29$ and $C_{CD} = 2 + 3/3.29 = 2.91$; $S_{CD} = R_{CB} = 3/(2 - 1/2.91) = 1.81$ and $C_{BC} = 2 + 2/1.81 = 3.10$; $S_{BC} = R_{BA} = 2/(2 - 1/3.10) = 1.19$ and, finally, $C_{AB} = 2 + 3/1.19 = 4.52$. The change in C_{DA} due to this new value of C_{AB} is negligible.

If a bending moment of 1,000 ft.lb. were introduced at A in AB, it would induce $1{,}000/C_{AB} = 221$ ft.lb. at B; 221/3.10 = 71 ft. lb. at C; 71/2.91 = 24 ft.lb. at D; 24/5.57 = 4 ft.lb. at A, and would continue around the frame again in the same manner.

Example 2—As a further example, the application of moment ratios to a building frame will be given. For purely illustrative purposes, the frame shown in the accompanying table, used also as an example in the Portland Cement Association booklet, *Continuity in Concrete Building Frames*, has been selected. Table I contains nine groups of computations for maximum moments at ends and centers of four beams. Moments, assuming ends fixed, are given for the ends of the spans and for midspans. K-values are all taken as unity. The upper and lower ends of the columns are assumed fixed, as in the booklet, and therefore, the stiffnesses of the columns are $1/(2 - 1/2) = 2/3$.

For problems of this type moment ratios may be computed with sufficient accuracy by the approximate formula, yielding results more rapidly than the exact equations. In using this formula, since the far ends of the columns are fixed, γ will be taken as 1.5.

$C_{BA} = C_{DB} = 2 + 1.5 \times 1/2 = 2.75$. All the other ratios $= 2 + 1.5 \times 1/3 = 2.50$. These values are entered in Table I above arrows indicating their direction.

Using these moment ratios, beam stiffnesses are calculated. $S_{BA} = S_{DB} = 1/(2 - 1/2.75) = 0.610$. All the other stiffnesses $= 1/(2 - 1/2.50) = 0.625$. These values are inserted at the ends of each span in the first box.

Distribution ratios are determined from them, as the ratio of beam stiffness to the sum of the stiffnesses of all the members of the joint, and entered in the box below. For example, $D_{AB} = D_{BD} = 0.625/(0.625 + 0.666 + 0.667) = 0.319$; $D_{BA} = D_{DB} = 0.610/(0.610 + 0.625 + 0.666 + 0.667) = 0.237$, etc.

The fixed-end dead load and total load moments are entered in the fourth and fifth rows, respectively. It should be noted, however, that the midspan moments for fixed ends are given for total load only.

To obtain maximum end moment at B in AB and BC, both AB and BC must be fully loaded, while CD carries dead load only. For convenience in carrying out the computation, joint B will be temporarily considered locked against rotation, and moments will be carried over to B with a moment ratio of 2. However, the distributions at joints A and C will be made using the given distribution

ratios. Joint B will be unlocked and the total unbalanced moment distributed according to its distribution ratios. The error in using the given distribution ratios at A and C instead of ratios based on a fixed end at B will be very small.

Maximum moments computed

Moments will be figured to no more than two significant figures in view of the approximations in *K*-values and column restraints. The carry-over from A, considering joint B locked, equals $-(-172 \times 0.319)/2 = +27$. The carry-over from C equals $-(78 - 70)0.242/2 = -1$.

The fixed-end total load moments at B are added to these carry-overs, giving a net unbalance of 199 — 79 = 120, which must be distributed to BA and BC. The portion going to BA $= -120 \times 0.237 = -28$ and to BC $= -120 \times 0.243 = -29$. The maximum moment at B in BA, then, equals 199 — 28 = 171 and at B in BC, —79 — 29 = —108.

The computation of maximum midspan moment is based on the assumption that it is approximately the sum of the simple beam midspan moment and one-half the algebraic difference of the final end moments when the span carries full load but adjacent spans only dead load. Accordingly, the maximum midspan moment can be obtained by adding two correction terms to the fixed-end midspan moment. These are the carry-over moments already computed in obtaining the maximum negative moments in that span multiplied by their respective values of $(C - 1)/C$, where C for the carry-over to the left is the moment ratio to the left and C for the carry-over to the right is the moment ratio to the right, except that the sign for the correction term to the left must be changed. (For variable moment of inertia the correction factor $= 1/2 \times \alpha/\beta \times (C - 1)/C$.)

In span AB the corrections are $-(2.75 - 1)(-16)/2.75 = +10$ and $(2.50 - 1)27/2.50 = +16$. Thus, the final maximum midspan moment is 99 + 10 + 16 = 125.

The results obtained in Table I, despite the roughness of the calculations, agree closely with those given in the Portland Cement Association solution, which uses two-cycle moment distribution. It can be concluded from this example that the method of moment ratios can produce solutions to building frame problems with only slightly more work than in two-cycle moment distribution. This additional labor is the computation of moment ratios and exact stiffnesses and is fully justified by increased accuracy of results and the other uses to which moment ratios may be put, as will be shown later. The apparent accuracy of two-cycle moment distribution in this example is due to the fact that the beam ends are almost fully restrained, as evidenced by the values of their moment ratios.

TABLE I—MONOLITHIC BUILDING FRAME

	A		B			C			D			E
	23 ft.–4 in.			14 ft.–0 in.			22 ft.–0 in.			18 ft.–0 in.		
	K = 1			K = 1			K = 1			K = 1		
Moment Ratio	2.50	2.75		2.50	2.50		2.50	2.50		2.75	2.50	
Stiffness	0.625	0.610		0.625	0.625		0.625	0.625		0.610	0.625	
Distribution Ratio	0.319	0.237		0.243	0.242		0.242	0.243		0.237	0.319	
F.E.M. Dead Load	.....	+ 91		— 37	+ 37		— 70	+ 70		— 59	.....	
F.E.M. Total Load	—172	+ 99	+172	— 78	+73	+ 78	—147	+85	+147	—126	+63	+126
Carry-Over	— 16	+ 10	+ 27	— 1	+ 1	— 2	— 11	+ 6	+ 13	— 20	+12	+ 7
Addition	—188	+ 16	+199	— 79	— 1	+ 76	—158	+ 8	+160	—146	+ 4	+133
Distribution	+ 60		— 28	— 29		+ 20	+ 20		— 3	— 3		— 42
Max. Moments	—128	+125	+171	—108	+73	+ 96	—138	+99	+157	—149	+79	+ 91

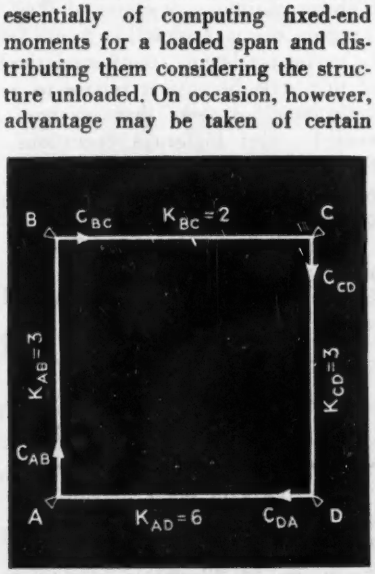


Fig. 4. The end moments in the members of a closed frame may be found by using moment ratios.

Generalization of ratios

Moment distribution by moment ratios as illustrated thus far consists essentially of computing fixed-end moments for a loaded span and distributing them considering the structure unloaded. On occasion, however, advantage may be taken of certain properties of loads and structures to save work in distribution by using moment ratios for loaded members.

For example, suppose it is known in advance what the final ratio of end moments in a given span will be. Take the moment ratio *C'* as this value and use it in obtaining the stiffness at each end of the span and in obtaining moment ratios of adjacent spans. It will not be necessary, then, to distribute moments from one part of the structure to the other past this span.

Example 3—In Fig. 4, for instance, let AB and CD carry a uniform load acting toward the interior of the frame, causing fixed-end moments of —1,000 at A and C and of +1,000 at B and D. Obviously, because of symmetry, the ratio between the final end moments in AD and also in BC equals —1; i.e., $C'_{AD} = C'_{DA} = C'_{BC} = C'_{CB} = -1$. $S_{AD} = S_{DA} = 6/(2 - 1/-1) = 2$ and $S_{BC} = S_{CB} = 2/(2 - 1/-1) = 0.667$. $C_{BA} = C_{CD} = 2 + 3/2 = 3.5$; $S_{BA} = S_{CD} = 3/(2 - 1/3.5) = 1.75$. $C_{AB} = C_{DC} = 2 + 3/0.667 = 6.5$; $S_{AB} = S_{DC} = 3/(2 - 1/6.5) = 1.63$.

$$M_{AB} = -M_{DC} = -1{,}000 + \frac{1.63}{1.63 + 2} \times 1{,}000 - \frac{1.75}{1.75 + 0.667} \times \frac{1{,}000}{3.5} = -758.$$

$$M_{BA} = M_{CD} = 1{,}000 - \frac{1.75}{1.75 + 0.667} \times 1{,}000 + \frac{1.63}{1.63 + 2} \times \frac{1{,}000}{6.5} = 344.$$

If a structure is symmetrical about a support and symmetrically loaded, it may be treated as if the structure on one side of that support were cut away and *R* for that support were infinite.

Part II, to appear in ENR Nov. 15, will illustrate how the method of moment ratios can be used to solve sidesway and moving load problems.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Atomic Energy

ATOMIC ENERGY FOR MILITARY PURPOSES—By Henry D. Smyth. 264 pp. Princeton University Press, Princeton, N. J. $1.25 (paper), $2.00 (cloth).

This book is the official report on atomic energy as written for and released by the Manhattan District of the Corps of Engineers, U. S. Army, with the addition of pictures and information on the New Mexico test of the first atomic bomb. It is a volume to be studied rather than read, as it is a somewhat rambling and disconnected account, with many spots bearing the scars of security deletions. In it will be found practically all that has been released to date, despite the many columns on the subject appearing every day in magazines and newspapers. If one is willing to search and piece together, the book provides an intelligent statement of the basic conception now held of the structure of the universe.

This book also gives a history of the development of atomic energy and outlines where construction men and the "Manhattan District" took over to produce the great plants visioned by scientists. It is a book worth studying to get a start in what may well be a new field for engineers.

Annual Wage Payments

GUARANTEED ANNUAL WAGES—By J. Chernick and G. C. Hellickson. 146 pp. University of Minnesota Press, Minneapolis, Minn. $2.50.

Among the many plans put forward for stabilization of American industry is the payment of a guaranteed annual wage to production workers, as has been done with success in a few instances. This little book sets forth the basic principles involved in such a system, and describes its operation in three outstanding examples: Nunn-Bush Shoe Co.; Procter & Gamble; and George A. Hormel Co.

For the construction industry the book's major interest lies in its chapter on guaranteed wages in the building industry. Advocates of the annual wage system have held that its application to the construction industry would help to stabilize employment in that field and would bring down costs by making possible a reduction in hourly rates.

The authors accept this theory as sound, especially if seasonal fluctuations in construction could be reduced. They cite the case of a Wisconsin builder who got his employees to accept what amounted to a reduced hourly rate on a guaranteed annual wage basis and then was able to level out his production curve by advertising actively for off-season work at reduced cost. Whether the system could be extended beyond the building field to general construction operations on a large scale remains to be seen.

One of the best features of this book is its presentation of the obstacles that stand in the way of application of the system as well as its advantages.

Highway Maintenance

MAINTENANCE MANUAL—By E. L. Worthington, State Maintenance Engineer, State Road Commission of West Virginia. 463 pp. Published by the commission, Charleston, W. Va., $4.

Though written primarily for the highway maintenance crews of West Virginia, this manual will be found to be useful far beyond the boundaries of that state because it relates to a multiplicity of tasks that are common to most highways operations. Even street maintenance authorities will find many useful ideas within its pages.

Especially valuable are its illustrations, of which there are many that save much text and present the information more effectively.

Miscellaneous Notes on Booklets and Reprints

ARGUMENTS in favor of constructing a lateral navigation canal along the Red River in Louisiana are contained in an illustrated pamphlet prepared by the Department of Public Works of Louisiana under the title "The Case for the Red River Lateral Canal." Copies can be obtained from Leo M. Odom, chief engineer of the department at Baton Rouge, La.

GUIDANCE MATERIAL for the use of men returning from the armed forces who are interested in civil engineering has been prepared by the National Roster of Scientific and Specialized Personnel. Included are a "Handbook of Descriptions of Specialized Fields in Civil Engineering" (Superintendent of Documents, Washington 25, D. C., 10c.); a description of the profession of civil engineering, in folder form; and "The Job of the Civil Engineer", Occupational Brief No. 16. Information concerning the two latter documents can be obtained from George A. Works, director of the National Roster, U. S. Employment Service, Department of Labor, Washington, 25, D. C.

New Engineering Books

AMERICAN LABOR UNIONS—By Florence Peterson. 338 pp. Harper & Brothers, N. Y. 16, N. Y. $3.

MANUAL ON HOT-MIX ASPHALTIC CONCRETE PAVING—111 pp. The Asphalt Institute, 801 Second Ave., N. Y. 17. Limited free distribution.

HUMAN LEADERSHIP IN INDUSTRY—By Sam A. Lewisohn. 12 pp. Harper & Brothers, N. Y. 16, N. Y. $2.

ECONOMIC RECONSTRUCTION—By 23 contributors; edited by Seymour E. Harris. 424 pp. McGraw-Hill Book Co., N. Y. 18. $3.75.

GUARANTEED ANNUAL WAGES—By J. Chernick and G. C. Hellickson. 146 pp. University of Minnesota Press, Minneapolis, Minn. $2.50.

MAINTENANCE MANUAL—By E. L. Worthington, State Maintenance Engineer, State Road Commission of West Virginia. 643 pp. Published by the commission, Charleston, W. Va. $4.

PROCEEDINGS: SOUTHEASTERN ASSOCIATION OF STATE HIGHWAY OFFICIALS—1945. 149 pp. Published by the association, M. L. O'Heale, Secretary-Treasurer, State Road Commission, Charleston, W. Va.

CALCULO DE ESTRUCTURAS RETICULARES—Third Edition. By Carlos Fernandez Casado. 382 pp. Published by Dossat, S.A., Madrid, Spain.

Reports and Pamphlets

ALUMINUM APPLICATIONS BY INDUSTRIES—Aluminum Company of America, Pittsburg 19, Pa.

(*Continued on p. 120*)

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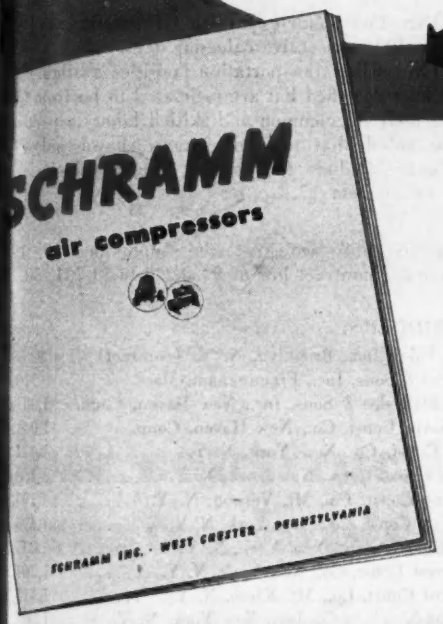
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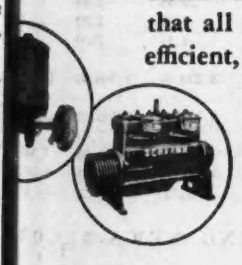

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

Wall and Appurtenant Works, Mill Creek, Cincinnati, Ohio

OWNER: U. S. Engineer, Cincinnati, Ohio; Col. Peschal N. Strong, engineer.

PROJECT: Reinforced concrete wall and embankment, constructing unit 4, Mill Creek Barrier Dam, completing west end connection between dam and high grounds. Concrete and line type construction. Work is at Mill Creek, near 8th Street, Cincinnati, Ohio. Overall length to be 1,500 feet with a height of 20 feet.

CONDITIONS: Contractor to furnish all form materials—no materials are to be furnished by the owner. Transportation facilities are readily available by rail, highway and water to the site. Wage rates are reported to be $1.82½ per hour for skilled labor; $1.50 per hour for semi-skilled; $.90 per hour for common. As the location of this Wall is very close to the Ohio River, rises in the Ohio and its resulting backwater presents a hazard that may affect total cost. The stipulated contract time was set at June 30, 1946.

BIDS: Three bids were received Aug. 14, 1945 ranging from the contract low of $199,689 to $295,804.

LIST OF BIDDERS:

1. Foley Construction Co., Cincinnati, Ohio..... $199,689
2. LaCrosse Dredging Co., Cincinnati, Ohio..... 211,351
3. Visintine & Assoc., Chicago, Ill..... 295,804

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clearing, grubbing and removal of surface structures.	1 job	$1,000.00	$1,000.00	$1,000.00
2. Preparation of embankment foundations	22,100 cu. yd.	.90	.80	.80
3. Structure excavation	5,900 cu. yd.	3.00	5.00	6.00
4. Excavation in borrow areas	38,350 cu. yd.	.80	.80	1.00
5. Embankment	43,850 cu. yd.	.60	.36	.90
6. Additional compaction	1,000 squares	.50	.01	.25
7. Seeding	1.2 acre	100.00	100.00	400.00
8. Compacted backfill	4,300 cu. yd.	3.00	2.00	5.00
9. Sand and gravel filters	1,050 cu. yd.	3.00	3.50	4.00
10. Six Inch (6") collector drain	965 lin. ft.	1.50	1.00	1.50
11. Twelve Inch (12") pipe drain.	350 lin. ft.	2.50	1.50	1.85
12. Copper waterstops and flashing	900 pound	.70	1.00	1.00
13. Catch basin	1 each	50.00	75.00	150.00
14. Manhole No. 1	1 each	150.00	150.00	175.00
15. Manhole No. 2	1 each	200.00	200.00	175.00
16. Manhole No. 3	1 each	220.00	200.00	175.00
17. Dumped riprap	960 cu. yd.	7.00	7.00	8.00
18. Paved gutters	90 sq. yd.	8.00	3.00	4.00
19. Hand placed riprap	60 sq. yd.	7.50	2.50	4.00
20. Cement	2,150 bbls.	2.50	2.50	2.00
21. Concrete	1,710 cu. yd.	23.00	33.00	43.00
22. Reinforcement	188,300 pound	.07	.07	.065
23. Gate storage house No. 1 superstructure complete (except door and frame)	1 job	2,000.00	600.00	2,800.00
24. Gate storage house No. 2 superstructure complete (except door and frame and miscellaneous metal)	1 job	1,200.00	350.00	1,400.00
25. Gate storage house doors and frames	3 each	200.00	150.00	200.00
26. Louvers	5 each	30.00	25.00	25.00
27. Road surfacing	125 sq. yd.	1.00	1.00	2.50
28. Guard posts	40 each	4.00	7.50	5.00
29. Split column closures	1 job	500.00	300.00	800.00
30. Fox dowels and expansion shields	1 job	1,500.00	800.00	600.00
31. Miscellaneous metal	21,530 pound	.20	.30	.40
32. Gate closures—gate 1A	1 job	3,000.00	5,000.00	10,000.00
33. Gate closures—gate 1B	1 job	1,500.00	1,100.00	3,010.00
34. Gate closures—gate No. 2	1 job	2,250.00	2,750.00	4,000.00

Gravity Type Concrete Dam Norwalk, Connecticut

OWNER: First Taxing District, Water Department of N walk. Connecticut: Mr. John E. Riorden, city engine Buck, Seifert and Jost, Consulting Engineers.

PROJECT: Construction of a gravity type concrete d on the Silvermine River to supplement the existing stora on this river. The dam is to be founded on a rock found tion: it will have a maximum height of about 100 ft. abo the foundation with an over-all length of approximat 1,000 ft. The construction site is 8 miles northwest Norwalk, Conn.

CONDITIONS: Contractor to furnish all materials and co plete work in 400 consecutive calendar days. Rail, highw and water (Norwalk) transportation facilities available. wage rates were specified but are estimated to be from $1 to $1.75 per hour for common and skilled labor respectiv (It will be noted that the unit prices shown below concrete do not include the cost of cement which is separately under item 17.)

BIDS: Thirteen bids were received September 19, 19 ranging from the contract low of $939,240 to $1,734,750.

LIST OF BIDDERS:

1. E. W. Foley Inc., Brooklyn, N. Y. (contract)..... $939,2
2. B. Perini & Sons, Inc., Framingham, Mass..... 976,2
3. C. W. Blakeslee & Sons, Inc., New Haven, Conn... 1,007,0
4. A. I. Savin Const. Co., New Haven, Conn..... 1,041,9
5. Walsh Const. Co., New York, N. Y..... 1,074,3
6. Cayuga Const. Corp., New York, N. Y..... 1,188,3
7. Garafano Const. Co., Mt. Vernon, N. Y..... 1,193,3
8. P. T. Cox Const. Co., New York, N. Y..... 1,196,1
9. Stock Const. Corp., New York, N. Y..... 1,245,6
10. Woodcrest Const. Co., New York, N. Y..... 1,267,2
11. Seaboard Const. Co., Mt. Kisco, N. Y..... 1,315,3
12. Morrison-Knudsen Co. Inc., New York, N. Y..... 1,667,
13. Spencer, White & Prentis Inc., New York, N. Y.... 1,734,7

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Cofferdams and pumping	Lump Sum	$20,000.00	$50,000.00	$111,5
2. Earth excavation and backfill	50,000 c. y.	2.00	1.85	1.
3. Rock excavation	5,500 c. y.	5.00	5.00	5.
4. Class A concrete masonry	500 c. y.	22.00	51.40	16.
5. Class B concrete masonry	73,500 c. y.	7.00	7.10	7.
6. Steel reinforcement added or omitted	2,000 lbs.	.07	.06	.
7. Furnishing and installing metal water stops	50,000 lbs.	.23	.10	.
8. Drilling holes in rock	300 l. f.	6.00	1.00	3.
9. Furnishing and placing grout	200 c. f.	10.00	2.00	1.
10. Furnishing and placing gravel	300 c. y.	4.60	5.50	4.
11. Furnishing and placing rip rap	500 s. y.	4.40	2.00	1.
12. Furnishing and installing sluice gates, valves and pipe fittings	Lump Sum	9,200.00	14,000.00	11,422.
13. Furnishing and installing miscellaneous metal work	Lump Sum	8,000.00	7,500.00	12,044.
14. Roadways and paths	1,200 s. y.	2.10	1.00	1.
15. Seeding	5 acr.	300.00	400.00	1,000.
16. Cleaning up	Lump Sum	5,000.00	5,500.00	2,500.
17. Furnishing Portland cement	80,000 bbls.	2.75	2.75	2.

New construction principle gives tires greater bruise resistance, longer life

USERS of big, costly off-the-road tires often had serious tire trouble. Every time one of the tires hit a rock, rut, or stump (and those damaging obstructions can't always be avoided), the tire took a walloping blow under ton-loads — shocks that frequently caused bruises, ply separation, and blow-outs. Delays and repairs were costly; perhaps the tire was beyond repair — an even heavier loss.

Then B.F.Goodrich developed a tire *shock shield.* This shield is a set of rubber breakers — layers of rubber-coated nylon cords — between the tread and the plies. The breakers are in *pairs,* with the cords in each pair running parallel to each other — but with each pair running in opposite directions to give balanced strength. The breakers are cushioned with thick layers of special shock-resistant rubber.

Under impact, the cords in the breakers stretch together, *not* across each other, and return to their original position. The blow is *distributed* and *absorbed* by the rubber cushions; the shock passed on to the cord body is greatly reduced.

This new shock shield helps users of BFG off-the-road tires get far greater service. Users report fewer bruises, far less ply separation, longer wear. One operator reports 17,226 miles from B.F.Goodrich tires compared to 12,501 for the best of three ordinary tires used; another—15,507 miles compared to 11,304 for the best ordinary tire.

The picture above shows the B.F. Goodrich "Super Traction" tire, especially engineered for traction and flotation. Wide space between cleats gives a big bite for heavy pulling and big yardage without slipping. The tread is self-cleaning too, and the body is flexible but strong.

It will pay you to find out more about these better off-the-road tires. Your own records of comparison tests of BFG tires alongside other makes will show you how you can make real savings.

Place tentative orders now — supplies are limited. See the local B.F. Goodrich dealer or write us direct. *The B.F.Goodrich Co., Akron, Ohio.*

Truck Tires BY

B.F. Goodrich

Black on White for Better Sight

WYTEFACE "A" Steel Tapes have *raised* black graduations on a crack-proof white surface. Easy to read in any light, from any angle. Faster measurements with fewer errors. Designed for hard service. White background is protected by raised steel markings and rims. Resists abrasion from rails, pipe, rocks, concrete. Protected against rust. See your dealer. Write for catalog.

K+E *Drafting Reproductions Surveying Equipment and Materials Slide Rules Measuring Tapes*

KEUFFEL & ESSER CO.
EST. 1867
NEW YORK • HOBOKEN, N. J.
CHICAGO • DETROIT • ST. LOUIS
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WYTEFACE "A"
STEEL MEASURING TAPES

Reports and Pamphlets

(*Continued from page* 116)

STANDARD VITRIFIED CLAY PIPE & FITTINGS—Clay Sewer Pipe Association, 50 W. Broad St., Columbus 15, O.

TOMORROW IS HERE—City Plan Commission, New Haven, Conn.

TENTATIVE MAJOR STREET PLAN—Toledo-Lucas County Planning Commissions, Toledo, Ohio. 15 pages.

CHEMICAL QUALITY OF GROUND WATER IN THE LOUISVILLE AREA, KENTUCKY—By H. E. Sublett. Kentucky Department of Mines and Minerals, Geological Division, Frankfort, Ky.

DRILLERS' LOGS OF WELLS AND TEST BORINGS IN THE LOUISVILLE AREA, KENTUCKY—Kentucky Department of Mines & Minerals, Geological Division, Frankfort, Ky.

THE WATER TABLE IN THE WESTERN AND CENTRAL PARTS OF LONG ISLAND, NEW YORK—State of New York Department of Conservation Water Power and Control Commission, Albany, N. Y.

ST. PAUL, MINN.—Annual Report of the Board of Water Commissioners for the year 1944.

PORTLAND WATER DISTRICT—Annual Report for 1944, Portland, Me.

LYNCHBURG, VA.—Annual Report of the City for the year 1944.

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO—Annual Report for 1944. Toronto, Ont.

RICHMOND, VA.—Annual Report of the Director of Public Works for 1944.

SPRINGFIELD, MASS.—71st Annual Report of the Board of Water Commissioners for 1944.

COMPACTION OF SUBGRADES AND EMBANKMENTS—Wartime Road Problems No. 11. Highway Research Board, 2101 Constitution Ave., Washington, 25, D. C.

PROCEEDING OF THE SIXTH ANNUAL HIGHWAY ENGINEERING CONFERENCE—Bulletin No. 30, University of Utah, Salt Lake City, Utah.

CAROLINA ROAD BUILDERS ASSOCIATION YEAR BOOK—Published by the Association, Raleigh, N. C.

ST. LOUIS, MO.—ANNUAL REPORT OF THE WATER COMMISSIONER.

CLASSIFICATION OF PLASTICS MOLDING MATERIALS—The Society of the Plastics Industry, 295 Madison Ave., New York, 17, N. Y.

MATERIALS AND MAN-HOURS FOR THE CITY OF NEW YORK POSTWAR PROGRAM—Prepared for the City Planning Commission by the United States Steel Co. New York.

NEW YORK STATE POSTWAR PUBLIC WORKS PLANNING COMMISSION—Third Interim Report, Albany, N. Y.

ST. LOUIS, MO.—ANNUAL REPORT OF THE CITY PLAN COMMISSION.

GRAND RAPIDS, MICH.—ANNUAL REPORT ON OPERATION OF THE SEWAGE TREATMENT WORKS.

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Albany—Tri-State Tractor Company
IDA.... Boise & Pocatello—Intermountain Equipment Co.
ILL..... Peoria & Springfield—A. E. Hudson Company
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Chicago—Great Lakes Supply Corp.
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MAINE. Portland—Maine Truck-Tractor Co.
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North Platte—Cornhusker Tractor & Equip. Co.
NEV.... Reno—Brown Motors
N. H.... Manchester—R. C. Hazelton Co.
N. J..... Trenton—Ross, Young, Dilts Company
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N. Y..... Buffalo—Dow & Company, Inc.
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OKLA.. Tulsa & Guthrie—C. L. Boyd Company, Inc.
ORE.... Portland & Eugene—Howard-Cooper Corporation
PA..... Butler—National Equipment Co.
Pittsburgh—Atlas Equipment Corp.
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State Equipment Co.
R. I..... Providence—Tractors, Inc.
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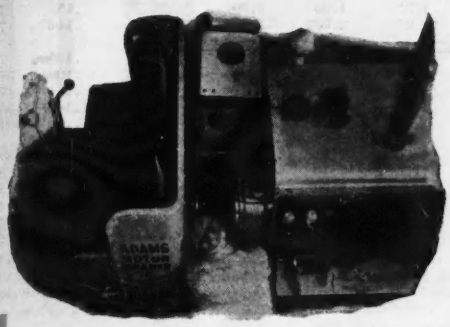
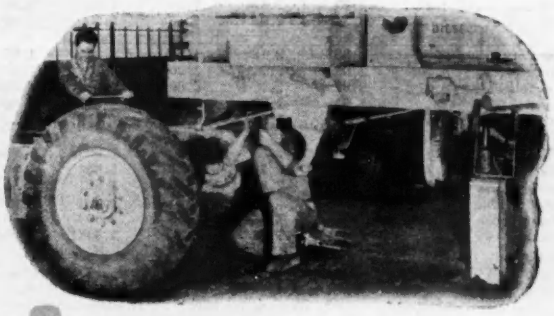
San Antonio—Jess McNeel Machinery Co.
Plainview & Sweetwater—Plains Mach. Co.
UTAH... Salt Lake City—The Lang Company
VA. .... Richmond—Municipal Sales Company
Richmond and Roanoke—Rish Equipment Co.
Alexandria—Phillips Mach. & Tractor Co.
WASH.. Seattle—Howard-Cooper Corp.
Spokane—Intermountain Equip. Co.
W. VA... Charleston and Clarksburg—Rish Equipment Co.
WIS. .... Eau Claire—Bark River Culvert & Equipment Co.

SEE Adams AD ON OPPOSITE PAGE

ADAMS MOTOR GRADERS EASY TO SERVICE



1 Clutch easy to reach and service



2 Transmission readily accessible

3 Engine easily removed

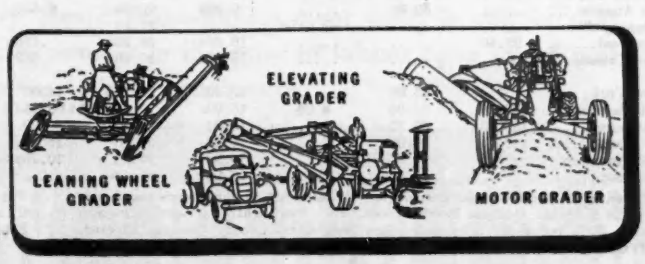
● From stem to stern Adams Motor Graders are engineered for fast, efficient, economical servicing. Note the examples pictured—observe how usually difficult-to-reach assemblies are easily accessible in Adams Graders:

1. Clutch is serviced without removing engine. A complete overhaul in about 4 hours.
2. Entire final drive disconnects and backs out easily for servicing transmission and lower half of engine.
3. If desirable, engine is quickly removable—much easier than on most motor graders.

These important time-saving, money-saving Adams features mean—*fewer repair-shop hours—more on-the-job working hours.* Ask your local Adams dealer for complete details. J. D. Adams Manufacturing Company, Indianapolis, Indiana.

Adams

ROAD-BUILDING AND EARTH-MOVING EQUIPMENT



MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

CONSTRUCTION MATERIAL and labor rates reported in November to *Engineering News-Record* reveal some changes from the preceding month. The principal changes were due to the OPA increased ceiling on clay tile, paving stone and brick. Denver, New York, Philadelphia and Chicago reflect this ceiling change in their prices but the latter city reports structural clay tile unavailable. The present wage rate for skilled labor has raised for plasterers, hoisting engineers and carpenters in 3 cities. Chicago plasterers rose from $1.85 to $1.90. Kansas City reported a 10c. per hour rise for hoisting engineers, while Minneapolis showed raises of 6c. per hr. for carpenters and a 10c. per hr. raise for hoisting engineers and plasterers.

Philadelphia reports an acute shortage of lumber and that this commodity is virtually impossible to obtain.

In Kansas City the price of vitrified sewer pipe lowered from $.35 to $.31 per ft. for std. 8 in. and from $.59 to $.56 per ft. for std. 12 in. In Kansas City the price of clay drain tile per 1000 ft. carload lots, f.o.b. lowered from $160.00 to $154.00 for 6 in. and $300.00 to $286.00 for 8 in.

Prices for lumber of all types and grades, though scarce, remained constant as did iron and steel prices.

Common labor rates on both building and heavy construction are unchanged from a month ago.

CEMENT, AGGREGATE, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., C/L lots, incl. 40c. per bbl. for bags, cash dis. not deducted)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE BLOCK 8x8x16-in.; truckload del.; per block		CONCRETE Ready Mix 1:2:4, over
	Cloth *a*	Paper	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	Sand-grav.	Lt.wgt. Agg.	50 c.y., del.
Atlanta	$2.77	$2.52	$2.47	$1.79	$1.89	$1.99	$1.79	$1.89	$1.59	$1.69	$0.17	....	$8.30
Baltimore	2.62	2.37	2.12	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	1.75‡	1.75‡	.125	$0.125*w*	7.45
Birmingham	2.80	2.25	2.10	1.75	1.75	1.50	.85	1.00	.90	1.15	.1425	....	5.80
Boston	2.97*b*	2.72*b*	2.52	1.50‡	1.50‡	1.05‡	1.25‡	1.35‡	....	....	.13	.155*w*	7.55*n*
Chicago	2.90	2.65	2.50	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.75‡	1.75‡	.18	.18*x*	....
Cincinnati	2.41	2.16	1.96	1.20	1.20	1.10	1.80	1.80	....	....	.12	.15*w*	6.70
Cleveland	2.59	2.34	2.19	1.75*i*	1.75*i*	1.25/1.65*i*	1.80*i*	1.80*i*	1.15*i*	1.15	.14	.14	7.45
Dallas	2.51	2.26	2.06	1.50*p*	1.70*p*	1.10*p*	1.69*p*	1.79*p*	....	....	.15	....	7.15
Denver	3.32	2.72	2.47	1.20	1.30	1.25	1.65	1.75	1.00	1.00	....	.15	7.25
Detroit	2.59	2.34	2.19	1.50	1.50	1.30	2.25	2.25	2.00‡	2.00‡	.13	.14*w*	7.25
Kansas City*v*	2.58	2.33	2.18	1.85	2.30	1.00	1.91	1.91	....	....	.125	.125*wy*	7.50
Los Angeles	3.20*e*	2.60*e*	....	1.30	1.30	1.15	1.30*f*	1.30*f*	....	....	.04*bb*	.10*aa*	7.25
Minneapolis	3.07	2.82	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	.14	....	7.35
Montreal	....	1.95*r*	1.79*r*	1.65‡*s*	1.65‡*s*	1.50*t*	.80*ct*	.90*ct*	....	....	.14*t*	.14*wt*	7.85*t*
New Orleans	2.41	2.16	1.92	1.67	1.65	1.22	....	....	.90	1.15	.19	....	9.25
New York	2.85‡	2.60‡	....	1.60*de*	1.60*de*	.90*de*	1.70*de*	1.80*de*	....	....	.16	.14*wcc*	8.25*k*
Philadelphia	2.73	2.48	2.28	1.55‡	1.65‡	1.20‡	1.90	1.95	1.10	1.10	.155	.155*w*	8.55
Pittsburgh	2.80	2.55	2.35	1.65‡	1.65‡	1.85‡	2.25‡	2.25‡	1.50	1.50	.17	.17*z*	8.40
St. Louis	3.00	2.72	....	1.75‡	1.40‡	1.25/1.40‡	1.25*h*	1.25*h*	.90*g*	1.10*g*	.155	.135*w*	8.60
San Francisco	2.21	2.01	1.71	1.36	1.36	1.36	1.46	1.46	....	....	....	.21*y*	7.55
Seattle	....*u*	3.00*e*	....	2.35d‡	2.35d‡	2.35d‡	2.85‡*cd*	2.85‡*cd*	....	....	.16	.16*y*	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* F.o.b. quarry. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount of 2 percent for cash in 10 days. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days. *s* 8% sales tax included. *t* 8% sales tax not included. *u* Withdrawn. *v* 20c. per bbl. discount; 20c. allowed for returnable cloth bags. *w* Cinder. *x* Waylite. *y* Celocrete. *aa* Pumice. *bb* 4 x 8 x 12 in. *cc* Also 8 x 18 x 18 in.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c. per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICE BASES AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

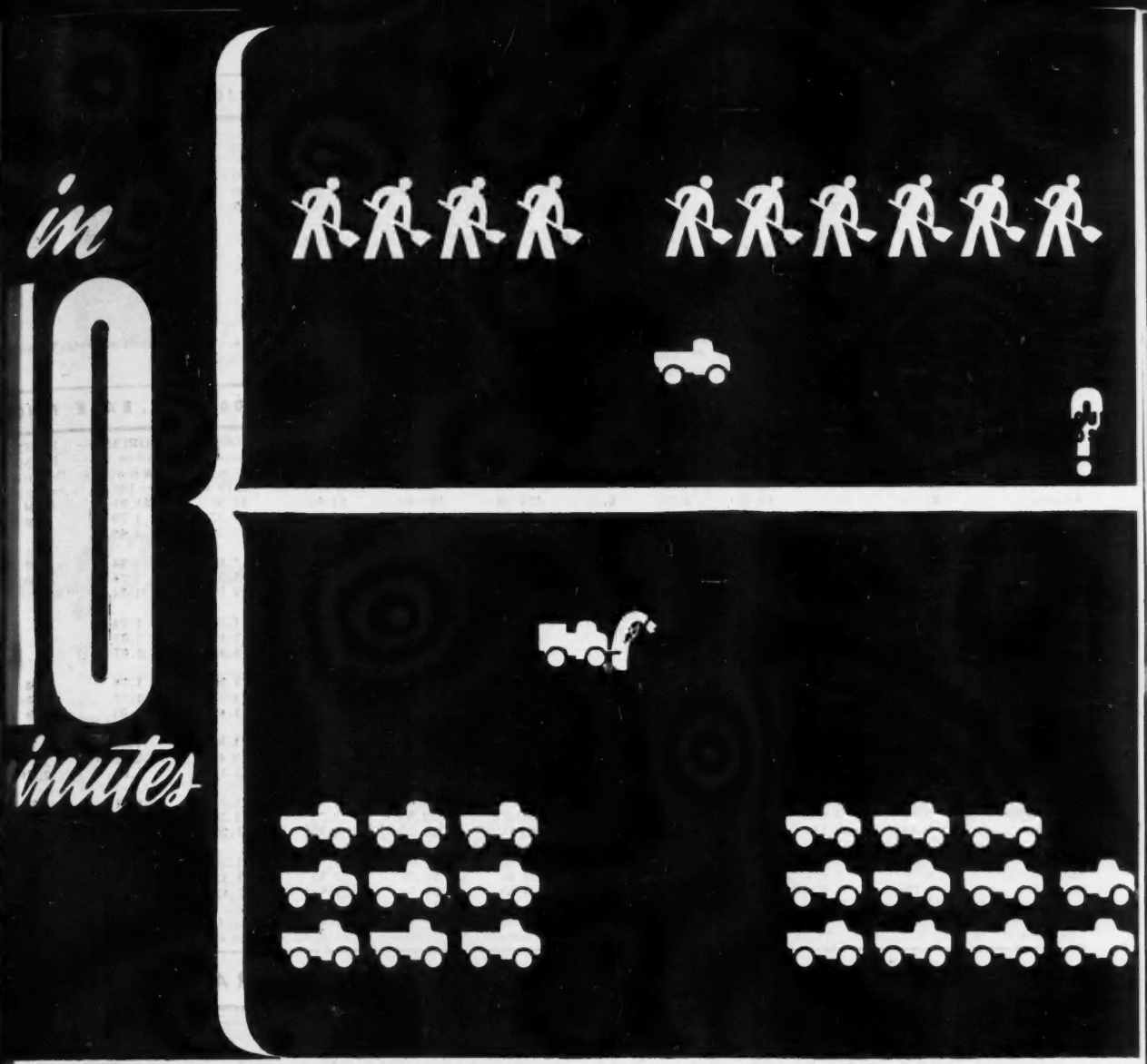
	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.90	$1.85	Ironton, Ohio	$1.80*	$1.75*	Richard City, Tenn	$1.80	$1.7
Dallas, Tex	....	....	Limedale, Ind	....	....	Steelton, Minn	2.00	1.9
Hannibal, Mo	1.90	1.85	Norfolk, Va	....	....	Universal, Pa	1.85	1.8
Hudson, N. Y	....	....	Northampton, Pa	1.75	1.70	Waco, Tex. (Plus 9c. tax in Tex.)	1.75	1.7
Independence, Kans	1.70	1.65	North Birmingham, Ala	....	....	Montreal City (Discount 10c. per bbl. 20 days)	1.68	1.6

*Destination price base; effective Sept., 17, 1945

PAVING BRICK, BLOCK, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICK AND BLOCK			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal., 80-300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OIL (Per gal.)	ASPHALT EMULSION (Quick-breaking) (Per gal.)	
	Granite per M lots of 50,000 4x4x8 in.	Brick per M 3x4x8½ in. carload lots	Wood per sq. 6d. 3½ in 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$18.53*e*	.....†	$0.0740*e*	.....†	$0.0806*he*	.....†	$0.0781*e*	$0.0806	.....†
Baltimore	150.00‡	49.00	85.00*m*	15.00*r*	21.00*r*	.06*r*	.09*r*	13.00*r*	23.00*r*	.06*r*	.07*r*	.14*r*
Birmingham	150.00	32.00*j*	.....	17.95	.....†	.0747	.....†	.0834*h*	.....†	.065	.095	.....†
Boston	85.00	59.00	3.75	15.00	24.00	.0625	.115	17.00	30.00	.0625	.0825	.145
Chicago	150.00	55.00	2.50/2.80*d*	14.00	22.50	13.00*g*	21.50*g*	.0575*h*	.15*h*	.05*n*	.09/.10*n*	.13/.15*n*
Cincinnati	120.00	55.75	.....	17.00	.....	.085	.....	12.25	.....	.07	.085	.....
Cleveland	120.00	34.00	3.57*l*	17.00	19.00	.085	.095	.10*h*	.11	.08	.10	.....
Dallas	.....	36.00	.....	13.65	20.30	.06	.11	16.00	24.80	.06	.05/.07	.07/.09
Denver	.....	16.11	.....	11.00	.....	10.00	.....	.045*h*	.....	.....	.....	.....
Detroit	.....	37.00	.....	18.06*f*	25.60*f*	.0734	.128	.0718*h*	.119*h*	.067	.0775	.1140
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	9.00*b*	23.00	9.50*bg*	24.00*bg*	9.50*b*	.....	.025	.072	.15
Minneapolis	.....	.....	2.01*7d*	.....	27.70	.....	.126	.....	32.64	.....	.....	.....
Montreal	92.40	.....	.....	16.60*k*	24.25*k*	.116*k*	.1485*k*	.115*hk*	.135*hk*	.08*k*	.135*k*	.188*k*
New Orleans	.....	.....	.....	13.50*a*	20.00*a*	.057	.088	.06*h*	.095*h*	.....	.080	.....
New York	.....	65.00	.....	17.40	24.20*p*	14.00	.....	.0725*h*	.1325*hp*	.....	.0725*p*	.119*p*
Philadelphia	150.00	62.00	4.06	15.00*r*	.....	14.00/15.00	.....	.0625*h*	.....	.....	14.00*gr*	.....
Pittsburgh	135.00	39.75	.....	18.00	23.00	.09	.16	20.00	36.00	.07	.06	.11
St Louis	.....	39.00	.....	16.00	22.00	15.00*g*	21.00*g*	.0575*h*	.12125*h*	.648	.06	.11
San Francisco	.....	45.00	.....	10.90	21.15	10.90*g*	18.00*gr*	12.90	17.50*r*	9.50*gr*	.0525	.1125
Seattle	.....	.....	.....	10.90*i*	21.90*i*	.....	20.40*gi*	11.40*i*	.....	10.90	.0525*i*	.0625*i*

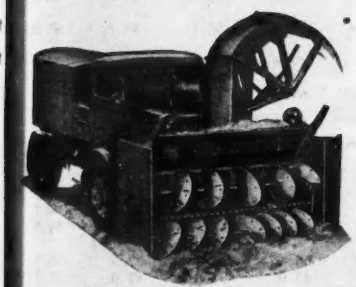
‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½ x 4 x 8½ in. *d* 2-in. interior block, 6-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3 x 3½ x 8½ in. *k* Tax included. *l* F.o.b. Toledo. *m* Per thousand. † Available on priority only and quoted specially. *p* No steel drum shipments except to armed forces. *r* February 1943 prices, none later available.



*Name of Municipality on request.

Your municipality can Soon Save the cost of

SICARD SNOW BLOWERS



Sicard Snow-Blowers have been demonstrating, since 1927, that snow and ice removal ceases to be a problem of cost, crews or conditions, when Sicard's versatile blowing, loading and scarifying features are available.

In the matter of costs, the long service life of a Sicard Snow-Blower (every Sicard Snow-Blower ever built is still in use) returns your investment in the form of labour costs saved and improved service to your community.

SNOW BLOWERS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet b	RIVETS ½-in. structural	WIRE NAILS Base d	SHEET PILING Base	STEEL RAILS Per Gross Ton Standard	Light	Re-rolled	TRACK SUPPLIES Angle Bars	Std Spikes c	Tie Plates c	Track Bolts
Birmingham	$2.10	$2.15	$3.75	$2.90	.....	$43.00	$45.00	$45.00*	$2.70	$3.25	$2.30	$4.75
Chicago	2.10	2.15	3.75	2.90	$2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Pittsburgh	2.10	2.15	3.75	2.90	2.40	43.00	45.00	45.00*	2.70	3.25	2.30	4.75
Buffalo	2.10	2.15	.....	.....	2.40	.....	.....	.....	....	....	2.30	....
Cleveland	2.10	2.15	3.75	2.90	.....	.....	.....	.....	....	....	....	....
Youngstown	....	2.15	.....	.....	.....	.....	.....	.....	....	3.25	....	....
Detroit	....	2.27‡	.....	.....	.....	.....	.....	.....	....	....	....	....
Gulf ports	2.47a	2.52a	.....	.....	2.85a	.....	.....	.....	....	....	....	....
Pacific ports	2.75a	2.80a	.....	3.40	2.95a	.....	.....	.....	....	....	....	....

‡ Delivered. a F.o.b. cars dock. b Rail steel same as billet prices. c Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. d Add switching charge $18 per * Per net ton.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LBS., BASE PRIC

	STRUCTURAL SHAPES Per 100 lb. base price	REINFORCING BARS* Per 100 lb., ¼ in., base price 15 tons or over b New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH Per 100 sq. yd., carload lots Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING Per 100 sq. ft., carload lots 4x16 in., No 5 & 10 wires	4x12 in., No 8 & 12 wires	6x6 in. No. 6 & 6 wires k Per 100 s. f.	SHEET PILING Per 100 l base price
Atlanta	$2.34	$2.40	$2.40	$.02½	$.10	$21.06	$23.00	$1.82	$1.35	$1.91	$3.04
Baltimore	3.70	2.90	2.75	....	.10	23.00	25.00	1.70	1.27	1.79	3.00
Birmingham	2.10a	2.15	2.15	.02½	.10	19.00	21.00	1.80	1.34	1.89	....
Boston	3.912	3.994	....	$20 C.L.	.10	18.50	29.50	1.76	1.31	1.84	2.77
Chicago	2.10a	2.15a	2.15a	.03	.05	21.50	23.50	1.67	1.25	1.75	2.40
Cincinnati	3.68	2.53cd	2.53cd	.....	.05	19.50	21.50	1.66	1.25	1.74	....
Cleveland	3.558h	3.10h	3.10h	.02½	.10	20.50	22.50	1.66	1.25	1.74	....
Dallas	4.25	3.17	3.17	....	....	25.50	27.50	1.93	1.42	2.03	....
Denver	4.57	4.09	....	....	....	26.50	26.50	1.97	1.45	2.07	....
Detroit	3.661‡	2.50‡	2.50‡	....	.10	30.00	30.00	1.68	1.26	1.76	2.66
Kansas City	4.19	2.61cd	2.61cd	.0	.05	24.50	26.50	1.78	1.33	1.87	2.874
Los Angeles	3.65f	2.575	2.425	.02½	.05	23.00	27.50	1.93	1.42	2.03	3.63
Minneapolis	3.81‡	2.73	2.73	.0	.10	21.00	23.00	1.80	1.34	1.89	2.734
Montreal	3.95i	2.80i	2.80i	....	....	31.00kk	46.00kk	2.76	3.44i	2.82im	....
New Orleans	4.158‡k	3.58k	....	.05	.10	23.50	22.00	1.82	1.35	1.91	2.873
New York	3.75	2.76e	2.76e	....	.15	17.50	19.50	1.76	1.32	1.81	2.74
Philadelphia	3.668	3.668	....	....	....	20.50	22.50	1.71	1.28	1.79	2.72
Pittsburgh	2.10a	2.15a	2.15a	.02½	.10	23.00	26.50	1.59	1.20	1.67	2.40
St. Louis	3.697	2.74	2.74	.0	.05	28.00	34.00	1.69	1.27	1.78	2.70
San Francisco	4.35	2.825	2.675	.02½	.10	21.00	24.50	1.93	1.42	2.03	3.70
Seattle	2.75e	2.80e	....	....	....	34.50	38.50	1.93	1.42	2.03	2.95e

‡ Delivered. a Mill prices. b 5-15 tons, add 15c. 1-5 tons, add 25c. Less than 1 ton, add 50c. c 20 tons or over Base. d Mill price plus freight. e F.o.b. dock. f Includes delivery in free delivery zone. g Less than 1 ton, add 25c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between billet and rail steel in many mills. h List price. i Plus Dominion and Province sales tax. k Quotation on changed basis; no actual price change. m Per sq. y

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.a	VITRIFIED SEWER PIPE Per foot, std. 8 in., s.s.	Delivered std. 12 in., s.s	ASTM 24 in.	C13-35 36 in.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM 12 in.	C 14-35 24 in.	WROUGHT STEEL PIPE Full standard weight, h 1 to 3 in., Butt Weld	Lap Weld 3½ to 6 in.; Lap Weld Galv.	Black	Galv.
										%	%	%	%
Atlanta	$50.66	$0.31b	$0.558bc	$3.082e	$5.70c	$110.00	$140.00	$0.45	$1.70	48.2	54.2	59.7	51.2
Baltimore	54.00	.35	.60	2.70	7.25	160.00	200.00	.65	1.90	65.5	57.5	63.0	54.5
Birmingham	46.00	.275	.495	1.95	5.50	100.00	220.00	.50	1.70	62.2	54.2	*59.7	51.2
Boston	56.40	.371r	.7135r	2.79r	7.6875r	170.00‡r	265.00‡r	.60	1.95	....	....	....	....
Chicago	55.33	.35	.675	2.70	7.00	100.00‡	150.00‡	.45	1.85	66.0	55.0	64.5	53.0
Cincinnati	54.27	.231	.4455	1.80	5.125	105.00‡s	170.00‡s	.75t	1.75t	57.1	43.4	54.0	39.6
Cleveland	55.75	.266r	.513	2.15	5.535	90.60	139.40	.36	1.40	68.5	57.5	66.0	54.5
Dallas	57.43	.31	.58	2.25	5.00	90.00	110.00	.46	1.57	....	....	....	....
Denver	62.56	.32‡	.576‡	2.376‡	.....	143.00‡	264.00†	1.00†	2.05†	58.4	50.4	55.7	47.2
Detroit	55.75	.385	.7425	2.925	7.75	170.00‡u	263.00‡u	.36	1.75	57.6	44.0	54.5	40.2
Kansas City	56.73	.31	.56	2.20	6.20	154.00	286.00	.45	1.60	35.6	46.1	46.2	59.4
Los Angeles	69.40	.325†	.585†	2.70†	6.75†	130.50	217.50	1.00	2.00	61.1	50.1	58.6	47.1
Minneapolis	60.10	.305†	.549†	2.196†	6.25†	.....	.....	.90	2.10	64.2	53.2	60.7	49.2
Montreal	67.00	.85o	1.50o	5.25p	8.50ep	45.00m	64.00m	.81lm	2.31m	....	....	....	....
New Orleans	52.78	.37r	.78	1.69	.....	150.00	220.00	.45	1.65	62.4	54.4	58.8	50.3
New York	53.40	.35	.675	2.835	7.35	.....	.....	.60	1.40	64.9	53.9	62.4	50.9
Philadelphia	52.00	.35	.675	2.835	7.35	165.00	225.00	.45	1.75	56.6	42.8	53.6	39.1
Pittsburgh	57.00	.266†	.513†	2.295†	5.945	97.80	154.20	.85g	2.00g	68.5i	57.5i	66.0i	54.5i
St. Louis	55.62	.31	.558	2.232	4.95	93.50	242.00	1.00f	2.10k	56.4	42.6	52.5	38.4
San Francisco	69.40	.3625d	.6525d	2.61	6.52	115.00	192.50	.58	2.34	45.0	31.0	41.0	26.0
Seattle	71.20	.40	.72	2.88	....	115.20	.....	.51f	1.44f	....	....	....	....

‡ Delivered. †F.o.b. a B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $50.00. Based on existing freight rates; subject to rate change. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. b Double strength. c List to dealer. d List. e 30-inch. f Less 5% for cash. g Culvert pipe. h Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.; ¼ in., 8½c.; ⅜ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92; 3 per cent tax on transportation costs not included. i Applies also at Lorain, Ohio mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh. Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base. Butt-weld—1 in. and 1¼ in. black 34 galv. 16; 1½ in. black 38 galv. 18; 2 in. black 37½, galv. 18. Lapweld—2½ in. to 3½ in. black 31½ gal. 14½; 4½ in. to 8 in black, 32½ galv. 17. Reinforced; spec. C 76-37. k Reinforced; spec. C 75-37. l Plus sales tax. m Centri. spun. n 27-in. pipe. o Less 50%. p Less 53%. s Price quotations on delivered basis since Mar. 1940; current f.o.b. price $84 for 6 in.; $130 for 8 in. t Reinforced pipe prices since May 1937; current plain pipe prices are: 12 in., 36c.; 24 in. $1.50. u Scarce: carload quantities not readily available.

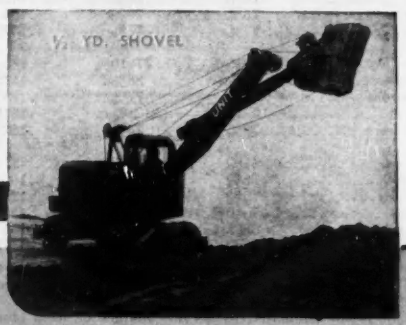
UNIT 357

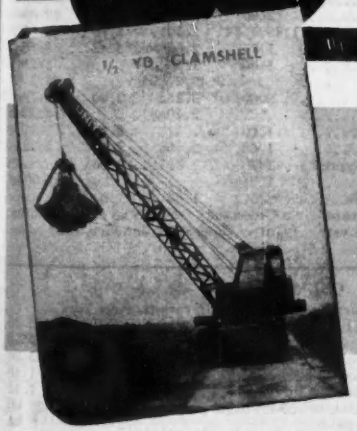
Self-Propelled MOBILE CRANE!

Here's a fast, mobile UNIT that rides on rubber . . . goes anywhere . . . over rough terrain or on paved highways . . . gets there in a hurry. Has the well-known UNIT power and stamina, plus motor truck speed and mobility. Operated by ONE man . . . powered by ONE engine . . . controlled from ONE position in cab. Ultra-modern in design, yet available at LOW COST. Ask for bulletin.

5-TONS
(7 tons with Outriggers)

New, Full Vision Cab—pioneered by UNIT — provides maximum visibility. Operator can see in ALL directions. Promotes safety. Increases efficiency.





UNIT CRANE & SHOVEL CORP. UNIT MILWAUKEE WISCONSIN

FULLY CONVERTIBLE TO ALL ATTACHMENTS

- SHOVEL
- DRAGLINE
- TRENCHOE
- MAGNET
- CLAMSHELL
- PILE DRIVER
- BACK FILLER

UNIT CRANE & SHOVEL CORP.
MILWAUKEE 14, WISCONSIN, U. S. A.

LUMBER, TIMBER PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR — All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face) *All Fir planks No. 2 common, Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)*									LONG LEAF Y. P. Merchantable grade up to 20 ft.		PLYWOOD Rail freight increment (See note for base price)	
	1x6 Rough	1x8 Rough	2x4 Rough	2x6 Rough	2x8 Rough	2x10 Rough	3x12 Rough	6x12 Rough	12x12 Rough	2x12 Rough	12x12 Rough	¼"	¾"
Atlanta	$41.00	$41.00	$35.50	$38.50	$37.50	$41.50	$45.00	.....	.....	$60.50	$64.00	$17.90	$21.85
Baltimore	44.00	46.00	44.00	46.00	47.00	52.00	65.00	.....	.....	115.00	120.00	18.25	22.25
	48.00	*49.00*	*55.00*	*55.00*	*55.00*	*57.50*	*68.00*	*$75.00*	*$75.00*	.....	.....	.....	.....
Birmingham	45.00	45.00	44.50	43.50	44.50	47.50	68.00	55.00	56.00	.....	.....	17.35	21.15
	50.00	50.00	49.50	48.50	49.50	52.50	72.00	.....	.....	67.50	70.00	.....	.....
Boston	60.00[3]	60.00[3]	60.00[3]	60.00[3]	60.00[3]	62.00[3]	66.00[3]	.....	.....	58.00[3]	58.00	18.25	22.25
	55.00	*55.00*	*54.00*	*54.00*	*54.00*	*54.00*	*58.00*	*58.00*	*58.00*	.....	.....	.....	.....
Chicago	55.00	55.00	58.50	54.00	54.00	60.00	68.00	.....	.....	80.00[l]	95.00[l]	14.60	17.80
	55.00	*55.00*	*54.00*	*54.00*	*54.00*	*55.00*	*56.00*	*57.00*	.....	.....	.....	.....	.....
Cincinnati	47.50	49.00	42.50	42.50	42.50	44.50	67.00	.....	.....	65.00	65.00	17.35	21.15
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cleveland	42.50[k]	42.50[k]	52.50[k]	51.00[k]	65.00	65.00	83.00	83.00	83.00	.....	.....	17.75	21.60
Dallas.....e	45.25	45.25	44.50	43.00	43.00	47.25	60.75	58.75	58.75	88.75	85.00	14.60	17.80
Denver.....‡	68.00[4]	68.00[4]	64.75[4]	65.25[4]	63.75[4]	64.75[4]	68.75[4]	*72.00*	*72.25*	.....	.....	10.45	12.70
Detroit	61.00	61.00	57.75	57.75	57.75	63.75	71.00	.....	.....	70.75	90.00	17.35	21.15
	57.00	*57.00*	*57.00*	*57.00*	*62.75*	*72.75*	*75.00*	*75.00*	*90.00*	.....	.....	.....	.....
Kansas City...a	69.00	69.00	67.00	65.50	67.00	69.00	84.00	.....	.....	84.00	94.00	12.60	15.40
	66.00	*66.00*	*59.50*	*59.50*	*59.50*	*59.50*	*75.00*	*80.00*	*80.00*	.....	.....	.....	.....
Los Angeles....c	*60.00*	*60.00*	*60.50*	*60.75*	*59.25*	*59.25*	*72.75*	*72.00*	*72.00*	.....	.....	9.90*gh*	12.05*gh*
Minneapolis....‡b	63.00[4]	62.00[4]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.60	15.40
‡	*69.00*	*69.00*	*60.00*	*61.00*	*59.00*	*60.00*	*61.00*	*65.00*	*65.00*	.....	.....	.....	.....
Montreal.....†[7]	*64.00*	*65.00*	*60.00*	*63.00*	*65.00*	*70.00*	.....	.....	.....	200.00	200.00	.....	.....
	90.00	*90.00*	*90.00*	*90.00*	*90.00*	*90.00*	*80.00*	*80.00*	*80.00*	.....	.....	.....	.....
New Orleans...	41.00	39.50	37.00	35.00	34.00	36.00	46.00	.....	.....	55.00	69.00	14.60	17.80
	30.50	*30.50*	*30.00*	*30.00*	*29.00*	*29.00*	*28.50*	*29.50*	*29.50*	.....	.....	.....	.....
New York.....	67.50	67.50	62.50	62.50	62.50	64.00	74.00	.....	.....	120.00*f*	125.00*f*	18.35	22.25
‡	.....	.....	*65.00i*	*65.00i*	*65.00i*	*65.00i*	[Range from $75 to $95]			.....	.....	.....	.....
Philadelphia...	75.00	75.00	75.00	75.00	75.00	75.00	75.00	.....	.....	130.00	130.00	18.25	22.25
	75.00	*75.00*	*75.00*	*75.00*	*75.00*	*75.00*	*85.00*	*90.00*	*90.00*	.....	.....	.....	.....
Pittsburgh.....	50.80	53.20	62.75	55.00	60.85	62.50	76.25	.....	.....	.....	.....	18.10	22.05
	69.20	*68.10*	*66.10*	*65.30*	*65.20*	*65.65*	*82.75*	*88.75*	*88.75*	.....	.....	.....	.....
St. Louis.....‡c	61.00	61.00	57.00	56.00	57.00 *	59.00	71.00	*75.00*	*75.00*	87.00	87.00	14.60	17.80
San Francisco..d	*41.00*	*41.00*	*36.50*	*36.75*	*36.75*	*36.75*	*37.50*	*36.00*	*36.00*	.....	.....	7.30*g*	8.90*g*
Seattle.....	*45.50*	*45.50*	*46.75*	*45.75*	*44.80*	*44.80*	*47.75*	*47.75*	*46.50*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [6] Spruce. [7] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* F.o.b. cars San Francisco freight rate. *e* 10% discount taken off. *f* Up to 18 ft. † Plus sales tax.

Note: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ½", $95.15; on ¾", $104.85; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum. *i* Ranges from $65 to $75. *j* Average price. *k* August 1943 price. *l* September price; none later available.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality	B quality	EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*	
Atlanta	74%	75%	$0.15	
Baltimore	78%	79%	.15	
Birmingham	76%	76%	.105	
Boston	77%	78%	.15	
Chicago	77%	77%	.15	
Cincinnati	77–10%	77–10%	.15	Price of 60% Ammonia Gelatin in $0.01 per lb higher than 40%
Cleveland	77%	77%	.19	
Dallas	76%	76%	.1625	
Denver	76%	76%	.155*c*	
Detroit	77%	77%	.1575	
Kansas City	77–10%	77–10%	.155	
Los Angeles	86%*d*	88%*d*	.1575	
Minneapolis	77%	77%	.155	
Montreal	40–10–2%*ab*	50–2%*ac*	.1675†	
New Orleans	70%	75%	.16	
New York	81%	82%	.22*f*	
Philadelphia	78%	79%	.15	
Pittsburgh	79%	79%	.1225	
St. Louis	77–10%	77–10%	.155	
San Francisco	66%	73%	.155	
Seattle	75%	75%	.1575†	

a Discount from list Sept. 1939; sales tax included, but 6% tax exemption not allowed for. *b* Single thickness. *c* Double thickness. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal St. add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb.
(except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla. and Me.	$0.105	$0.13	$0.15
W. of Miss. to Rocky Mtn. States, Fla. and Maine.	.11 –.1175	.135 –.1475	.155 –.1675
Rocky Mtn. States	.11 –.1225	.135 –.1525‡	.155 –.1725‡
Pacific N. W. States	.1075–.12	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1125	.135 –.1425	.155 –.1625

‡ F.o.b. Louviers, Colo., or Butte, Mont.

PILES TIES— F.O.B.

PILES

Prices per linear foot, fir and pine, bark on, f.o.b. cars, New York. Fir based on Wash. and Ore. points to New York shipping area; pine based on freight from Norfolk.

Dimensions	Points	Length	By Rail — Pine*	Fir
12-in. at butt	6-in.	30 to 50-ft.	$0.34	.....
12 in.— 2 ft. from butt	6-in.	50 to 59-ft.	.35	.....
12-in.— 2 ft. from butt	6-in.	60 to 69-ft.	.36	.....
12-in.— 2 ft. from butt	6-in.	90 to 100-ft.	....	.5575
13-in.— 3-ft. from butt	5-in.	91 to 100-ft	....	.5608
14-in.— 2-ft. from butt	6-in.	50 to 69-ft.	.41	.6175
14-in.— 2-ft. from butt	6-in.	70 to 79-ft.	.43	.59
14-in.— 2-ft. from butt	5-in.	80 to 85-ft.	.54	.....
14-in.— 2-ft. from butt	5-in.	85 to 89-ft.	.57	.....
14-in.— 2-ft. from butt	5-in.	90 to 100-ft.	....	.60

* Pine piling over 80-ft. available only in limited quantities.

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.50	....	$2.00	....
	Pine	2.00	$3.00*a*	2.50	$3.00*a*
New York	S. L. Sap Pine	1.43/1.54	2.59	1.76	2.86
	Mixed Oak	1.71	2.59	2.42	3.58
Birmingham	White Oak	1.00	1.60*a*	....	2.25*a*
Chicago	Red Oak	....	2.45/2.65*a*	....	3.35/3.60
Los Angeles	Douglas Fir	2.00	3.25*a*	2.90	4.70*a*
Philadelphia	Red Oak	....	2.10*ag*	....	3.25*ag*
St. Louis	White Oak	1.60	....	2.19	....
	Red Oak	1.63	2.15*a*	2.19	3.25*a*
	Sap Pine or Cypress	1.70	....	2.06	....
San Francisco	Douglas Fir	1.25*bcf*	..	....	3.00*caf*
Montreal	Birch or Maple	....	1.65	1.04	....

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6"x8"x8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* F.o.b. cars. † Out of market. *g* January 1943 price, none later available.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.50– 3.10
Chlorine cylinders, liquid, per lb., delivered	.0525
Calcium chloride, 77–80%, flaked, 100-lb. paper bag, del'd, ton.	18.50–35.00
Silicate of soda, 52 deg. in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.15
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00–25.00
Sulphate of copper, in bbl., per 100-lb	5.00

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE PARTITION—SCORED Per M lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	STRUCTURAL CLAY TILE—LOAD BEARING—SCORED Per M lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	BRICK Per M in quantity Common backing	Straight hard	LIME Per ton, Hydrated finishing	In paper, Common hydrated	Carload lot, Pulverized, or lump
Atlanta	$104.00	$114.00	$199.00	$234.00	$244.00	$250.00	$18.25	$20.04	$26.54	$15.04	$15.04
Baltimore	84.00	90.00	170.00	200.00	260.00	300.00	17.00k	21.00k	19.00	14.00	2.50m
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	16.50	23.00	18.11	13.64	2.25o
Boston	103.75a	110.65a	207.45a	248.90	.....	.....	20.00i	20.00i	21.00†	.....	16.00
Chicago	85.80	91.70	172.60	x	x	x	17.00	18.00	17.00	15.00	12.50
Cincinnati	65.55	69.90	131.20	148.70	210.35	240.45	27.75	27.75	15.50	13.00	.....
Cleveland	77.25	82.50	196.00	.....	.....	.....	22.75	22.75	15.75	13.25	.....
Dallas	71.40	76.40	145.30	183.50	238.00	294.50	15.25i	16.75i	19.00	15.00	15.00
Denver	99.00	112.00	185.00	214.00	248.00	294.00	21.50	18.00	25.00j	17.00j	20.00
Detroit	92.70	96.70	174.50	198.80	257.20	294.30	20.50	20.50	18.00	16.00	16.00
Kansas City	67.00	69.00	89.00c	128.00	163.00	189.00	17.50	18.50	19.32	13.00	10.92
Los Angeles	73.50†r	89.50†r	128.00c†r	210.00†r	368.00†r	460.00†r	13.50	15.00	16.50	17.50	17.50
Minneapolis	87.00b	92.80b	157.30b	.....	189.00b	262.00b	25.50	31.50g	21.00	16.00	19.00
Montreal	92.50a	98.50a	196.25a	151.50a	100.50at	134.50at	22.16†u	33.20†u	24.60u	15.00u	14.00u
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	99.40	106.00	145.75c	235.00k	287.40k	355.80k	19.50/20.50	.....	20.00	14.00	17.00
Philadelphia	112.10	119.60	224.20	269.10	321.20	405.10	20.75	23.75	19.00	16.00	15.00
Pittsburgh	74.20	79.15	148.40	233.00	284.00	325.00	21.25	23.25	17.90	15.40	2.55m
St. Louis	67.00	72.00	130.00	190.00	244.00	290.00†	20.50	19.50	22.00	18.00	2.50m
San Francisco	96.00	108.00	144.00	108.00t	.....	.....	21.50	.....	24.00	23.00	2.50m
Seattle	115.00	125.00	230.00	.....	.....	.....	20.50f	24.00f	20.00s	20.00s	20.00s

† F.o.b. a Smooth. b Carload lots delivered to job. c 6x12x12 in., 3-cell. d Not load bearing. e 48 lb. tile. g Selected common. h F.o.b. Perth Amboy, N. J. i F.o.b. Warehouse only. f LCL. k $1.00 discount if paid in 10 days. l Lump. m Per bbl., 180 lb. o Per bbl., 200 lb. p 280 lb. bag. r 5% discount 10 days s 2% discount for cash. t 5½x8x12. u 8% sales tax included. x Not available. z 6x12x12-in.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

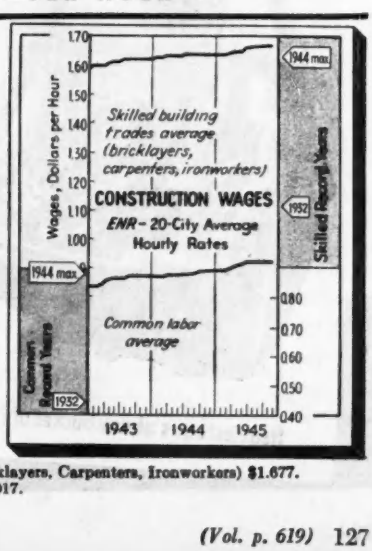
	RED LEAD Per 100 lb. in 600-lb. (Approx.) bbl Dry a	WHITE LEAD Per 100 lb. in oil	READY-MIXED PAINT Per gal., drums Graphite b	Aluminum b	Ferric Oxide d	ROOFING SUPPLIES Rolls, slate surfaced, 85–90 lb. per sq.	Asphalt felt, per 100 lb.	Carload lots f.o.b. factory Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$10.25	$14.125	$1.30	$2.25	$1.20	$1.85	$1.72	$1.72	$0.305	$27.00
Baltimore	10.00	13.75	2.00	3.00	2.50	2.30	2.70	2.70	.40	29.00
Birmingham	10.25	14.125	2.35	3.50r	1.98r	2.09	1.98	1.98	.32	28.35
Boston	10.00	13.75	1.75	2.50	2.31	2.00‡h	3.30‡us	3.30‡us	.25‡	21.00‡
Chicago	10.00	13.75	....	....	....	1.75hf	1.74hf	1.82hf	.33f	23.00f
Cincinnati	10.00	13.75	1.70	2.90	1.60	2.20	2.10h	2.10h	.33	25.00
Cleveland	10.00	13.75	1.70	2.90	1.60	1.71	1.63h	1.61h	.237	25.00
Dallas	10.00	14.50	1.88	2.11n	.05l	1.75h	1.66h	1.66h	.35	39.00
Denver	10.00	14.25	....	....	.27l	2.45	2.95	2.95	.35	28.00
Detroit	10.00	13.75	1.75	3.00	1.60	2.25	2.25	2.25	.50	23.00
Kansas City	10.00	13.875	2.30g	2.55gr	2.16g	2.19	2.30	2.30	.28	27.50
Los Angeles	10.25	14.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	10.00	13.875	....	....	....	1.7123i	1.6243hi	1.6243hi	.32	23.00
Montreal	.....	11.05	2.50p	4.90p	3.15p	4.02t	2.58t	3.01t	.89t	2.10kl
New York	10.00	13.75	2.03	....r	1.82	1.7098	1.6273a	1.6273o	.26	23.00
Philadelphia	10.00	13.75	1.60/1.80	2.20r	1.55	2.25	2.71	2.71	.32	23.00
Pittsburgh	10.00	13.75	1.05	1.95	.80	1.95	1.84h	1.84h	.34	26.00
St. Louis	10.00	13.75	2.28s	2.89s	1.96s	1.75	1.66	1.66	.33	24.00
San Francisco	10.25	14.00	1.80	2.75n	1.35	1.71	2.40	2.40	.33	20.50
Seattle	10.25	14.25	1.90	3.00	....	2.15	2.16h	....	.35	26.50j

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. a Red lead prices change frequently due to pig lead price changes. b U. S. War Dept. Spec. 3-49A. c ASTM Spec. D266-31. d 80% minimum ferric oxide. e Subject to 25% discount. f Distributors' price to contractors. g 5 gal. can. h Per roll, 65 lb. i Minneapolis and vicinity. j Asphalt pitch. k Per 100 lb. l Per lb. m Per bbl. n May, 1941 price. o 60-lb. roll. p Plus 8% sales tax. r Not available, except on priority rating; then quoted specially. s December, 1942 price. t Federal tax included. u 90-lb. roll. z Truck delivery.

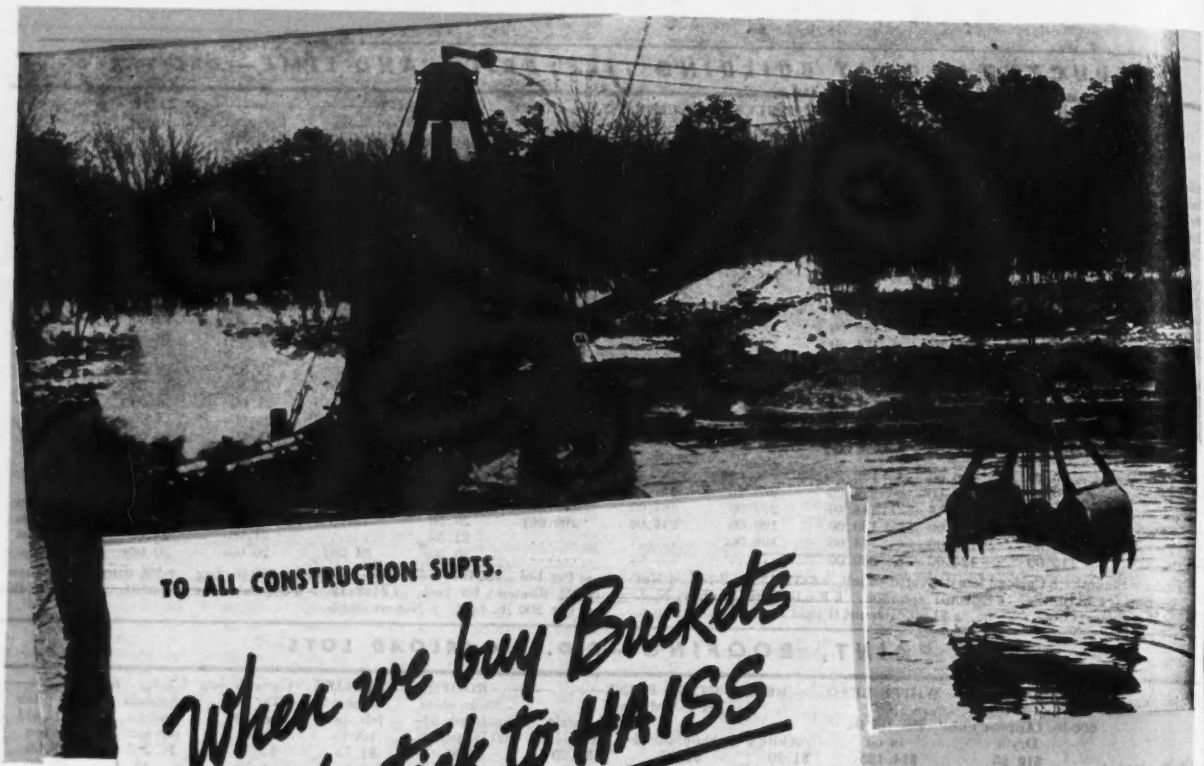
SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$1.50	$1.25	$1.50	$1.25	$1.50	$0.40	$0.50
Baltimore	1.75	1.4375	1.80	1.625/1.80	1.725	.80	.80
Birmingham	1.75	1.25/1.50	1.625	1.375 /1.625	1.65	.65	.65
Boston	1.625	1.50	1.675	1.50 /1.875	1.667	1.00	1.00
Chicago	1.90	1.85	1.85	1.85	1.90	1.20	1.20
Cincinnati	1.825	1.60	1.725	1.45 /1.60	1.75	.90	.90
Cleveland	1.875c	1.65	1.875	1.875	1.875	1.085	1.125/1..55
Dallas	1.625	1.25	1.50	1.75	1.625	.60	.75 /1.25
Denver	1.80b	1.50b	1.50b	1.50 /1.625b	1.55	.825b	.825b
Detroit	1.725	1.50	1.825	1.675/1.825	1.775	1.00	1.00
Kansas City	1.75	1.575	1.70	1.70	1.75	.975	.90
Los Angeles	1.50	1.35	1.625	1.375	1.667	.875	.875
Minneapolis	1.625	1.50	1.625	1.60	1.725	.95	.95
New Orleans	1.625	1.375	1.625	1.55	1.50	.70	.80
New York	2.00b	1.85b	2.00	2.00b	2.00b	1.10	1.10
Philadelphia	2.00	1.88	1.90/2.00	2.25	2.00	.90	.90
Pittsburgh	1.90	1.75	1.75	1.8125	1.875	1.00	.90
St. Louis	1.90	1.70	1.90	2.00	1.75	1.00	1.00
San Francisco	1.875	1.50	1.75	1.50/1.75	1.75	1.00	1.00
Seattle	1.845	1.545	1.745	2.00	1.845	1.145	1.145
Montreal*	1.06	.96	1.01	.91	1.06	.61	.66

b 7 hr. day. c Prevailing rate on government work. * Cost of living bonus now included in basic wage.



ENR Skilled Average; (Bricklayers, Carpenters, Ironworkers) $1.677.
ENR Common Average; $0.917.



TO ALL CONSTRUCTION SUPTS.

When we buy Buckets let's stick to HAISS

J.E.

More and more contractors are coming to say just that, "Let's stick to Haiss"... It comes when they've discovered that a Haiss Clamshell handles bigger payloads—by total yardage per day, month or year. The "plus" in yardage-handling efficiency is the natural result of a combination of design advantages. *And* the stand-up ability that keeps a Haiss at top efficiency through a long life...Catalog No. 143 on Hi-Power Digging Buckets—No. 343 on "Multi-Sheave" Rehandlers.

HI-POWER for Digging
Highest Closing Ratio (up to 7:1)
Lower Sheaves up out of the muck
Heaviest Jaws of any bucket of its kind

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HAISS HI-POWER

CLAMSHELL BUCKETS • LOADERS • PORTABLE CONVEYORS

New Aids to the Constructor

MANUFACTURERS' LATEST DEVELOPMENTS IN EQUIPMENT AND MATERIALS

Electrode Holder

Designed to prevent slipping in a welder's mitt or glove when changing rods, a 300-amp. Stubby model electrode holder features an all-plastic, four-cornered collar. This is said to make rod-changing quicker and easier, to hold small rods upright and away from contact with the work, and to keep the collar cooler than the cap.—*Manufactured by Martin Wells, 5886 Compton Ave., Los Angeles 1, Calif.*

• • •

Aluminum Waterproofer

Heavy bodied and ready mixed, a new No. 2700 Dolfinite aluminum waterproofing substance may be brushed or sprayed freely on damp or wet surfaces. It forms a uniform heat-repelling film as well as waterproofing brick, concrete, stucco or canvas surfaces.—*Dolphin Paint & Varnish Co., 921 Champlain St., Toledo 3, Ohio.*

• • •

Transparent Housing

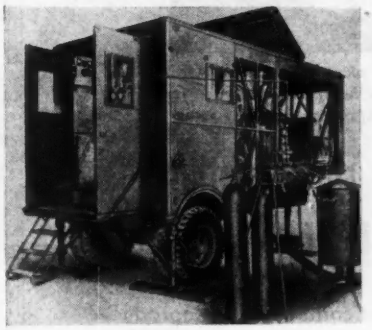
Useful in underwater salvage operations, lighting units of Lucite methyl methacrylate resin cylindrical transparent housing are water and vapor tight. According to the manufacturer, this housing provides good light transmission and is practically unbreakable under normal working conditions.

Complete lighting units of this plastic are available in 6, 8, 15 and 30-watt sizes.—*Commercial Reflector & Mfg. Co., Los Angeles, Calif.*

• • •

Mobile Generator

A mobile generator used by the armed forces to produce oxygen at advance bases is expected to have important peacetime applications on isolated construction jobs where on-the-spot production of oxygen will result in important savings in transportation time and space. Production of oxygen is attained with 6-12 in. of glass fiber insulation around the cold area—*Air Products, Inc., Chattanooga, Tenn.*



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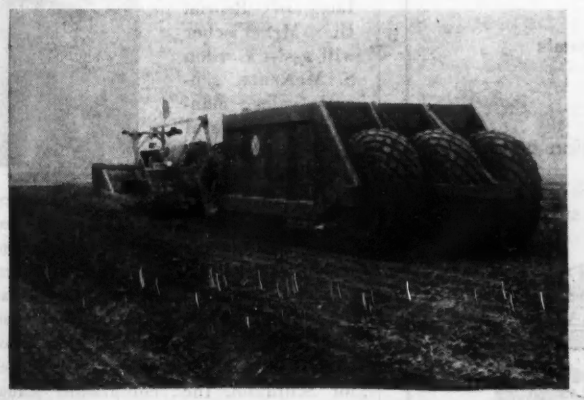
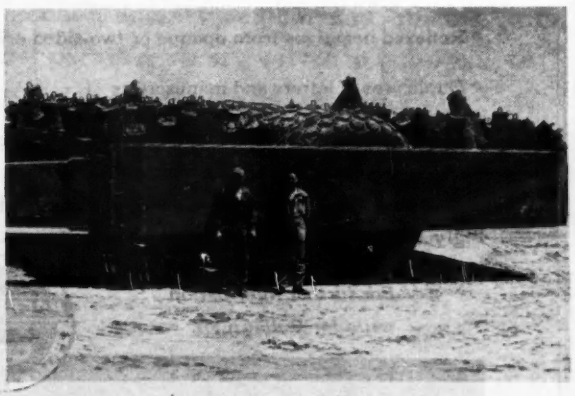
New Electrodes

A-C nickel manganese, A-C Mo Mang manganese, X2, and X3 electrodes are new additions to the Allis-Chalmers arc welding electrode line. The first two electrodes have wide application in the mining, cement, and railroad industries for repair and building of worn equipment. Characteristics of the weld deposit allow it to work-harden to 550 Brinell. Hard surfacing electrodes X2 and X3 are used to protect parts subject to extensive wear, the X2 for severe abrasion and mild impact and the X3 for severe impact and mild abrasion.

A-C nickel manganese and A-C Mo Mang manganese are available in assorted sizes, both bare and coated, the coating being a combination, suitable for both A-C and D-C welders. X2 and X3 electrodes are available in assorted sizes with combination coating only.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*





Construct mammoth rollers for West Coast airfield work

The two machines pictured above were built by the R. G. LeTourneau Co. for use as compaction test rollers on airfields in California.

The rig shown at left is 8 ft. high, 40 ft. long, and designed to carry a 100-ton load. Used to compact surfaces of runways recently enlarged at Santa Monica, the box has a capacity of 705 cu.ft., is loaded with 162,000 lb. of steel ingots. Spacing of the three rear and two front wheels provides 100 percent coverage for a width of 9 ft. Clearance below bed of box is 1½ ft.

At right is a 10-ft. high, 150 ton roller built for use on the now-abandoned construction at Merced Army Airfield. A 95-hp. tractor hauls the rig, which travels on four 36-40-tires weighing 5,000 lb. each, normally carrying 40 lb. air pressure. To increase the load, the tires can be filled with four tons of water each.

Construction at Merced was ordered abandoned early in September after runway grading was nearly completed.

Low in sensitivity to ordinary electric light, Photo-Arc can be printed in a normally lighted room — even in your drafting room.

Peerless Photo-Arc reproductions speed up new products

Now you can make any type of contact photo-reproduction with new ease, new speed, new standards of quality:

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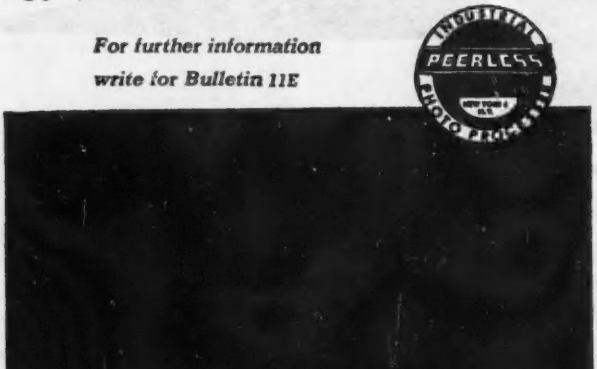
For further information write for Bulletin 11E



Manufacturers' Activities

WILLIAM C. SIMPSON, who has been associated with Lukens Steel Co., Coatesville, Pa., since 1934, has been named manager of sales of Lukenweld, Inc., a subsidiary.

Simpson had been manager of direct sales for Lukens Steel Co. since 1943, and previous to that was manager of the Pittsburgh, Pa., sales office. He has served also as a research engineer, and in the sales department. A graduate of Lehigh University, Simpson went to Lukens Steel Co. in 1934 from Bethlehem Steel Co. In 1938, he was named manager of the Pittsburgh sales office, where he continued until 1940, when he was recalled to Coatesville to handle large war contracts.

APPOINTMENT of Walter N. Fischer to the newly created position of assistant to the general sales manager is announced by R. G. LeTourneau, Inc., of Peoria, Ill. Mr. Fischer will assist Gordon S. McKenty, general sales manager, in general office administration, and work closely with divisional sales managers.

Four years ago Mr. Fischer joined LeTourneau as manager of its war contracts division. In charge of interdepartmental coordination with the war sales structure, he directed more than $100,000,000 in war sales. For three years he was Chicago district manager for Schramm, Inc., compressor manufacturer. He had been affiliated with Schramm previously for 12 years in West Chester, Pa., and with west coast distributors.

MARVIN L. HOLZER, has replaced R. T. Carpenter as structural and field engineer for the Portland Cement Association in western New York, with headquarters in Buffalo. Mr. Holzer, a grad-

of the University of Michigan, was ously engaged in design and con- tion in the New York City area.

ASTER-VIBRATOR Co., Dayton, Ohio, facturer of gas-electric generator ts, concrete ting equip- electric r hammers ther indus- roducts, an- es the ap- ent of Ar- T. Stanton as al sales di- for domestic xport sales, romotion, merchandising and ad- ng.

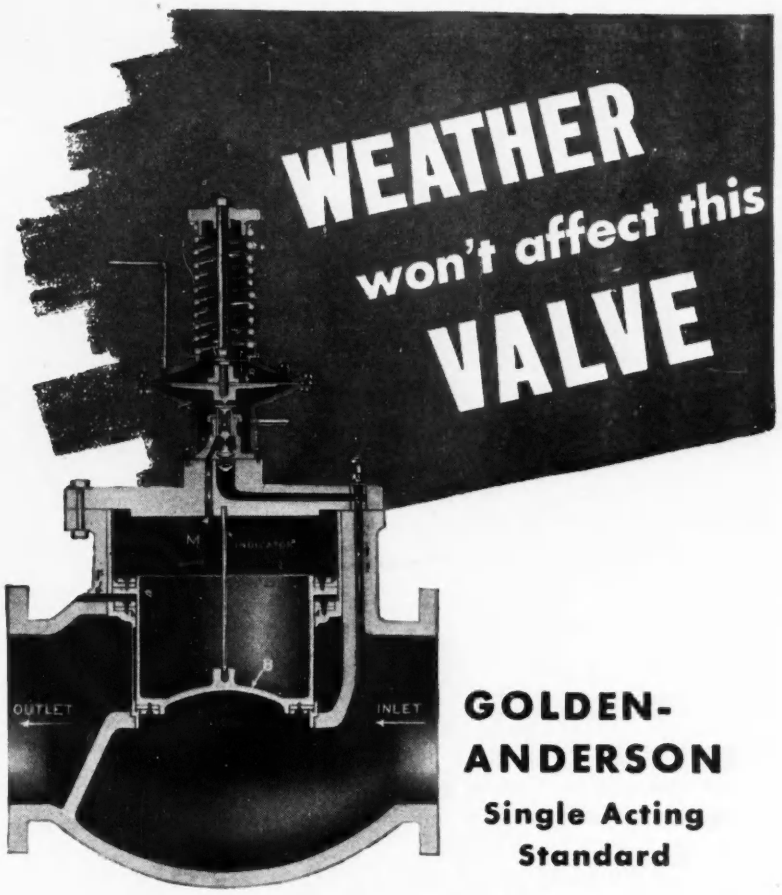
er director of sales of the Chrys- rp. and a mechanical and indus- ngineer, Mr. Stanton returns after ears in Washington, where he was from Willys-Overland to help ize the Division of Contract Dis- tion—one of the first war agencies. recently he served as chief of tions in WPB's Production Facili- Bureau.

T. COL. HUBERT E. SNYDER, re- returned to inactive status in the of the U. S., has been appointed esident of the Penn Metal Corp. nsylvania, in charge of the cor- d metal pipe division, with head- ers in Philadelphia. Colonel Sny- ved in the Control Division, Head- rs Second Service Command, or's Island, New York.

twelve years previous to his call ive duty in the Army, Colonel was vice-president and general er of the Shelt Co. of Elmira, a large fabricator of corrugated pipe. He has had long and var- perience in civil and mining engi- g, including nearly three years on nstruction of Gatun Locks, Pan- Canal.

W. ELLIS, regional director of the Production Board's construction nery division, Minneapolis, Minn., turned as vice president and sales ger of the construction machinery on, Waterloo Construction Co., loo, Ia.

A LOCOMOTIVE WORKS, INC., Ohio, announces the appointment ul R. Ehrgott as general sales er of the shovel and crane divis- charge of domestic and export He was formerly district sales er of the eastern Pennsylvania ry with headquarters at Bethle- Pa.



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As important as the filters themselves is the chemical feeding equipment used to correct water content for many industrial or municipal plants.

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Manufacturers' Publications

Trailer Mixers—A catalog of ger drum sizes and heavy duty co tion trailer mixers. The booklet describes pumps, compressors, mixers, hoists, loaders and equipment.—*The Jaeger Machine Columbus 16, Ohio.*

Equipment Catalog—Latest inf tion on modern, high-speed earth ing and lifting equipment is con in a new catalog. Profusely illust this book describes and pictures tire equipment line and distri shop and service facilities.—*R. G. Tourneau, Inc., Peoria, Ill.*

Heating and Melting Equipm Of interest to water works, sew partments, public utilities and pip contractors is this catalog, telling fire guns, weed burners, steam thaw concrete heaters, ground thawers, heaters, tar and asphalt melting k —*Hauck Manufacturing Co., Bro 15, N. Y.*

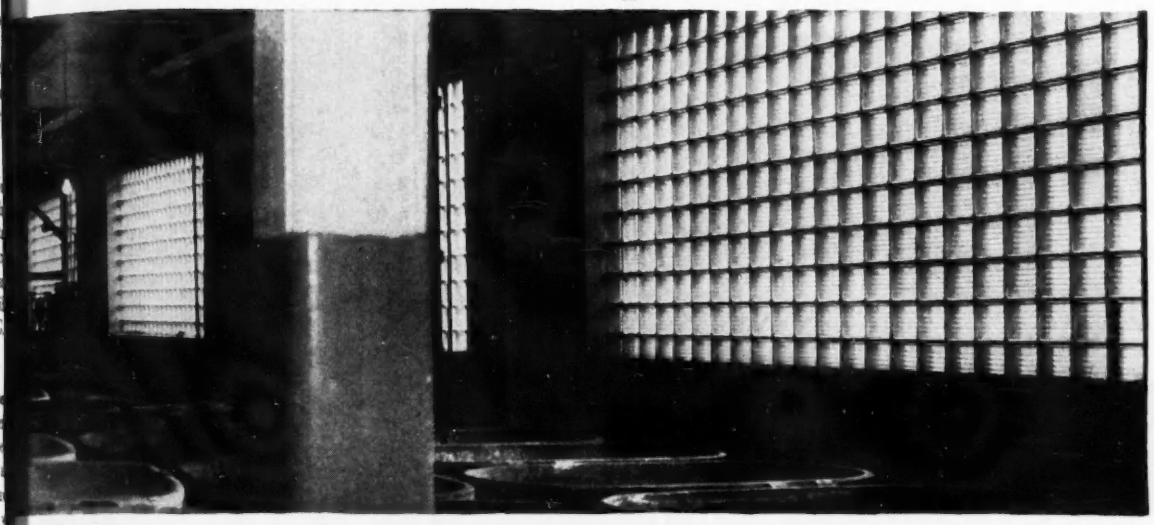
Electronics in Air Filtration— booklet is not too technical, and in an interesting manner what "c clean" air means to industry and can be realized by electronic air f tion.—*The American Air Filter Inc., Louisville 8, Ky.*

Air Compressors—An unusuall tractive 44-page catalog tells of a plete line of stationary and por compressors.—*Schramm, Inc., Chester, Pa.*

Adhesives in Industry—This 12 booklet should be helpful to use adhesives, sealers, coating or insul compounds, impregnators and s deadeners. It describes adhesive erations in many different indus methods of application and a list the physical properties. It lists ous formulae and shows the visc bonding range, color, weight, ch teristics, uses, and Government sp cations. Each booklet contains pu sheet for the analysis of any adh problem.—*Minnesota Mining Manufacturing Co., Saint Paul 6,*

Materials Hauling—Profitable ing from shovel or dragline is desc in a new 4-page folder. It shows to cut the cost of hauling rock and material.—*R. G. LeTourneau, Peoria, Ill.*

EETING MODERN STANDARDS WITH *PC Glass Blocks*



, HUMID WORK ROOMS panels of PC Glass Blocks have proved to ordinary sash, which frequently rots, rusts, warps and needs ng. They also help to maintain desired temperature and levels, to lessen condensation.

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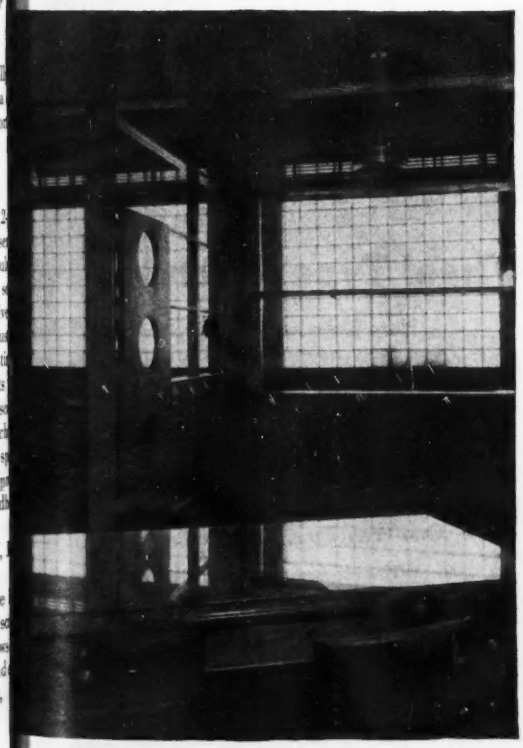
OFFICES present an excellent opportunity for PC Glass Blocks to their practical advantages. An ample supply of diffused daylight d here, and PC Glass Block panels supply it, even to desks from lighting areas.



MOST people who are concerned with plant construction and modernization already know that PC Glass Blocks are attractive and practical. This will remind you of *all* the ways PC Glass Block construction serves and saves in new and modernized plants and offices.

PC Glass Blocks distribute generous floods of daylight over wide areas. Insulating properties lessen heat losses through lighting areas, help maintain temperature and humidity levels, ease the load of air-conditioning and heating equipment. Infiltration of chilling drafts, gritty dust, is prevented because PC Glass Blocks are an integral part of the wall. They exclude unpleasant sights, dampen disturbing sounds.

Glass surfaces are quickly and easily kept clean. PC Glass Blocks do not break readily, rarely if ever need repair or maintenance.

In planning new construction and modernization projects in offices, stores and factories, you can insure added beauty, comfort and economy by using PC Glass Blocks. Pittsburgh Corning Corporation, Room 769,632 Duquesne Way, Pittsburgh 22, Pennsylvania.

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632 DUQUESNE WAY, PITTSBURGH 22, PA.

Elections and Activities

Charles C. Eeles, of the Ohio Fuel Gas Co., has been elected 1945-46 president of the Toledo, Ohio, Technical Council, composed of 15 engineering societies and organizations. Other officers are: Russell W. Abbott, Libbey-Owens-Ford Glass Co., vice president; and William A. Nelden, of the B. F. Sturtevant Co., secretary-treasurer.

The Merrimac River Valley Sewage Board has been re-established with the following members: James P. Smith, Salisbury, Mass.; Dr. Thomas V. Uniac, Lawrence; Thomas A. Berrigan, Westwood; Stephen Kearney, Lowell; and James Cleary, Haverhill. One of the first duties of the board, out of existence since 1933, will be participation in a survey of sewage disposal conditions in the valley with the Massachusetts Public Health Department.

B. L. Wise, assistant manager, welder division, Federal Machine & Welder Co., Warren, Ohio, has been elected vice-president of the central district of the American Welding Society.

Formation of a council of scientific, technical and engineering groups with a membership of more than 3,000 in Akron, Ohio, district has been started. A committee headed by T. C. Dee of Ohio Edison Co. is at work on the organization plans and later will present to the groups a constitution and program of operation. Other officers of the committee are Wendell R. LaDue, vice chairman, and D. W. Hayes, secretary. Dee represents the Society of Professional Engineers; LaDue, city water department head, is from the American Society of Civil engineers; and Hayes, of Goodyear Tire and Rubber Co., the American Institute of Chemical Engineers.

R. M. Garth has been elected president of the Engineering Professions Club at Jacksonville, Fla. W. J. Fowler was named vice-president. Other new officers are R. W. Cloues, secretary; W. D. Schultz, treasurer, and N. C. Farmer, program director.

Datus E. Proper of San Antonio, has been elected chairman of the Texas state board for registration of professional engineers. He succeeds E. W. Pittman, Beaumont. J. S. Hudnall, Tyler, was elected vice chairman and Carl L. Svenson, Lubbock, was elected secretary. Other board members are J. B. Thomas, Ft. Worth, and A. Mitchell, Corsicana.

Henry J. Nichols has been elected chairman of the Boston, Mass., Authority. The first objective of authority will be the construction piers in Charlestown, a project already approved by the state legislature postponed until materials would available. It is expected that a time salaried director will be appointed soon.

Edward W. Staves, Southbridge, Mass., has been elected chairman of special postwar highway commission Clifford R. Cusson, Haverhill, Mass. was named vice-chairman. Staves chairman of the commission last year when it recommended a 6-year highway construction program involving an outlay of $156,000,000.

Paul A. Jenkins, formerly manager of the Chicago, Ill., district of the War Production Board, has been appointed full-time executive secretary of the Chicago Technical Societies Council according to John F. Seifried, president. Permanent headquarters of the council have been established at 327 West Jackson Blvd., Chicago.

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COMBINATION BULLDOZER AND SNOW PLOW
for
International Industrial Wheel Type Tractor

Here is the low-cost efficient snow fighter you have been waiting for!

This newly developed all-purpose tool may be used as a Bulldozer or for snow removal. There are three interchangeable units including a Bulldozer, a Vee-Type Snow Plow and a Reversible Blade Plow which may be used as a Snowdozer or a One-Way Plow.

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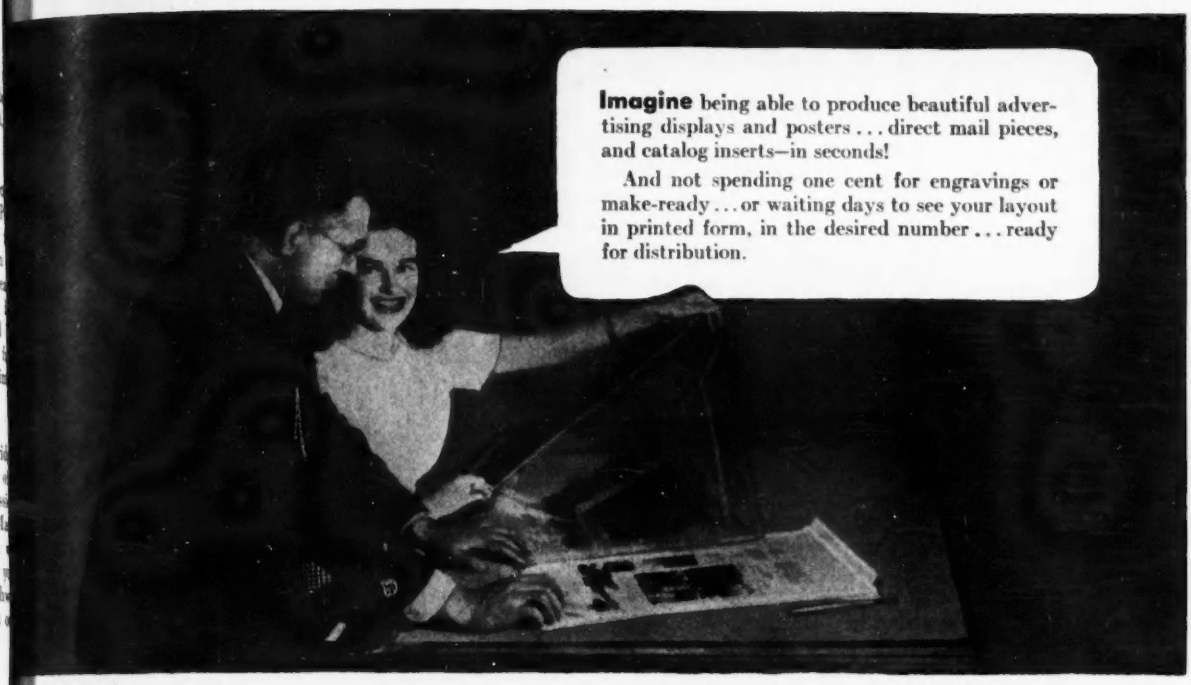
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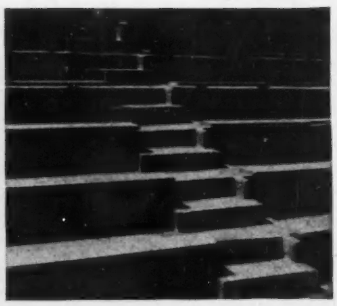

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Above is shown the stadium of Sharon High School at Sharon, Penna. This is a poured concrete structure, built in 1933, and after only eight years disintegration was very serious and endangered the stability of the structure.

In 1941 we were called upon to strengthen and recondition this stadium, which we did with reinforced "GUNITE" of two inch minimum thickness.

The view to the left shows the chipping and standblasting completed and the reinforcing mesh in place. To the right is the completed job, better than when new.

This is just one of many similar and kindred jobs which we have done with "GUNITE," dozens of which are described in our Bulletin A2300.

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30 years experience and special steels forged at the edges assure that extra wearing quality you need. All widths, lengths, and thicknesses; punched ready to fit your machines; Write for special Bulletins—give type and name of machines you operate.

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Men and Jobs

Maj. Herbert Goodkind, who play prominent part in planning the R River assault and in assembling bridging equipment and materials for it, has been given the Bronze Star Medal for meritorious service by **Maj. Gen. C. R. Moore,** chief engineer, E.T.O. The ceremony took place in Communicati Zone Headquarters in Paris. Ma Goodkind is the son of Morris G kind, well known as chief bridge e neer of the New Jersey State High Department.

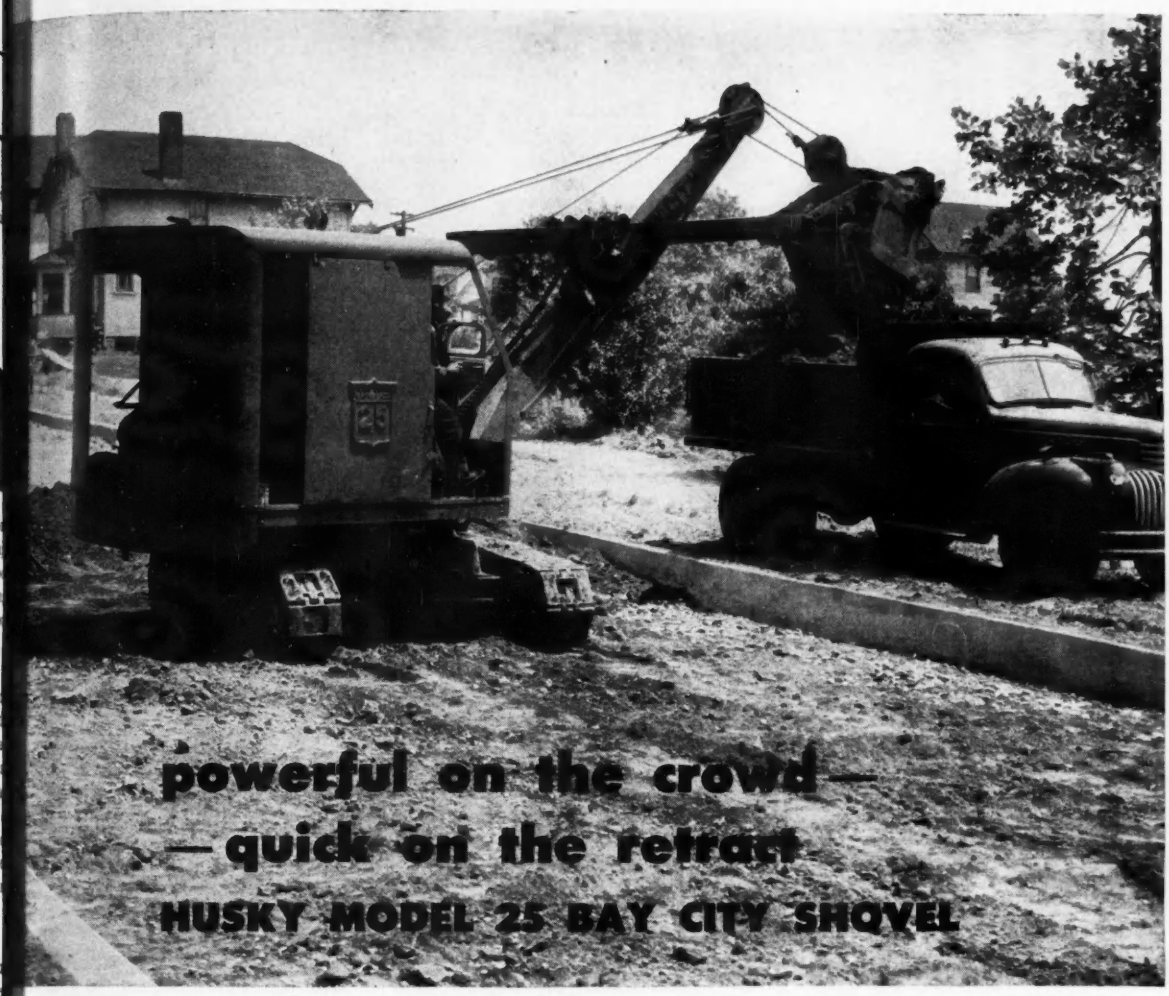
L. M. Huggins, who was rece appointed district engineer for Idaho office of U. S. Public R Administration, has established h quarters in Boise. F. M. Smith is ing district engineer for Utah. The vision of the offices was brought ab because the work to be done is m than can be handled adequately by office for the two states.

Joe D. Wood, former Idaho s commissioner of public works, is dir ing engineering investigations of I ho's water resources for the Id Water Utilization Committee. study was undertaken to deter policies for industrial and agricult uses of water to avoid contamina The committee includes representati of municipalities, food processors, m ing, lumbering, agricultural, recla tion and recreational groups.

Coleman Barthlow has been pointed city engineer at Toppen Wash., in addition to his previous du as fire chief and city inspector of bu ings, electricity and plumbing.

R. H. Kenyon, district state high engineer at Wakima, Wash., has b transferred to department headquart in Olympia as engineer of plans contracts. His Yakima post has b taken by J. W. Hamilton, formerly Pasco.

Austin Brockenbrough, Richm Va., engineer and former assis PWA director in Virginia, has b promoted to captain in the U States Naval Reserve. He received



Talk about power and speed!—the BAY CITY Model 25 half-yard shovel, 5 ton crane, has plenty of both. One-piece chain crowd operates independent of hoist, hence utilizes full engine power. Bucket can be thrust beyond and above boom tip when necessary. Retract speed is twice crowd speed—capacity load is swiftly swung clear and dumped. BAY CITY Model 25 is the ideal sturdy, fast shovel for scores of jobs like road grading where it does a clean, quick job as illustrated above. Husky? Ruggedly built with unit-cast alloy steel lower carbody and revolving table. Tandem drums on separate shafts. Heavy duty differential drive. Fully convertible from shovel to crane, drag, hoe, or skimmer. For consistently greater yardage, put the BAY CITY Model 25 to work for you. Other BAY CITY cranes and shovels available in a wide range of sizes and models—both crawler and pneumatic tire mounted. Call your nearest BAY CITY dealer today or write directly to BAY CITY SHOVELS, INC., Bay City, Michigan.

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SHOVELS • DRAGLINES
CRANES • HOES • CLAMSHELLS

SEE YOUR NEAREST DEALER for Bay City excavating and material handling equipment in sizes from ⅜ to 1¼ yards having crane rating up to 20 tons. Both crawler and pneumatic tire mounting.

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It's *proved:* The addition of Solvay Calcium Chloride to portland cement provides:

1. **QUICKER SET**—Tests prove that the time of initial and final set is reduced by two-thirds with Solvay Calcium Chloride in the mix.
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3. **COLD WEATHER PROTECTION**—Solvay Calcium Chloride offsets dangerous effects of sudden drops in temperatures, shortens protection period, adds extra protection against freezing.

Solvay Calcium Chloride helps winter concreting without changing the normal chemical action of portland cement—and at cost so low that the savings in finishing, forms, protection and labor far outweigh the cost of the calcium chloride.

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degree of civil engineering at Cornell University.

Emil C. Jensen, engineer formerly in charge of the sanitary engineering section of the Washington State Department of Health, has been appointed to succeed Max S. Campbell as chief of the division of public health engineering in the same department. He has been with the department since 1941, previous to which he spent three years as sanitary engineer for the City-County Health Department at Yakima, Wash.

Maj. Edward F. Brownell of Minneapolis, Minn., has been named post engineer at Camp Ellis, succeeding Lt. Col. Robert C. Edgar, transferred to Edmonton, Alta., for duty with the Northwest Service Command. Major Brownell served as assistant post engineer under Colonel Edgar. A graduate of the University of Minnesota in civil engineering, he entered the Army, June, 1942, and served one year in the district engineer office, Detroit, before going to Camp Ellis.

Charles W. Chance, superintendent of the municipal water works at Hillsboro, N. C., prior to entering the Army in June, 1943, has been promoted to staff sergeant with the Air Transport Command's Pacific Division in Manila.

Lt. Col. E. W. Scripture has resumed his post as director of research for the Master Builders Co., Cleveland, Ohio, after three years' service in the Corps of Engineers. Colonel Scripture was commissioned in 1942 and almost immediately was assigned to the Office of the Chief Engineer, European Theater of Operations, where he was placed in charge of the control and statistical section. He spent his first two years overseas in England and then went to France in August of 1944. He was awarded the Legion of Merit and the Bronze Star.

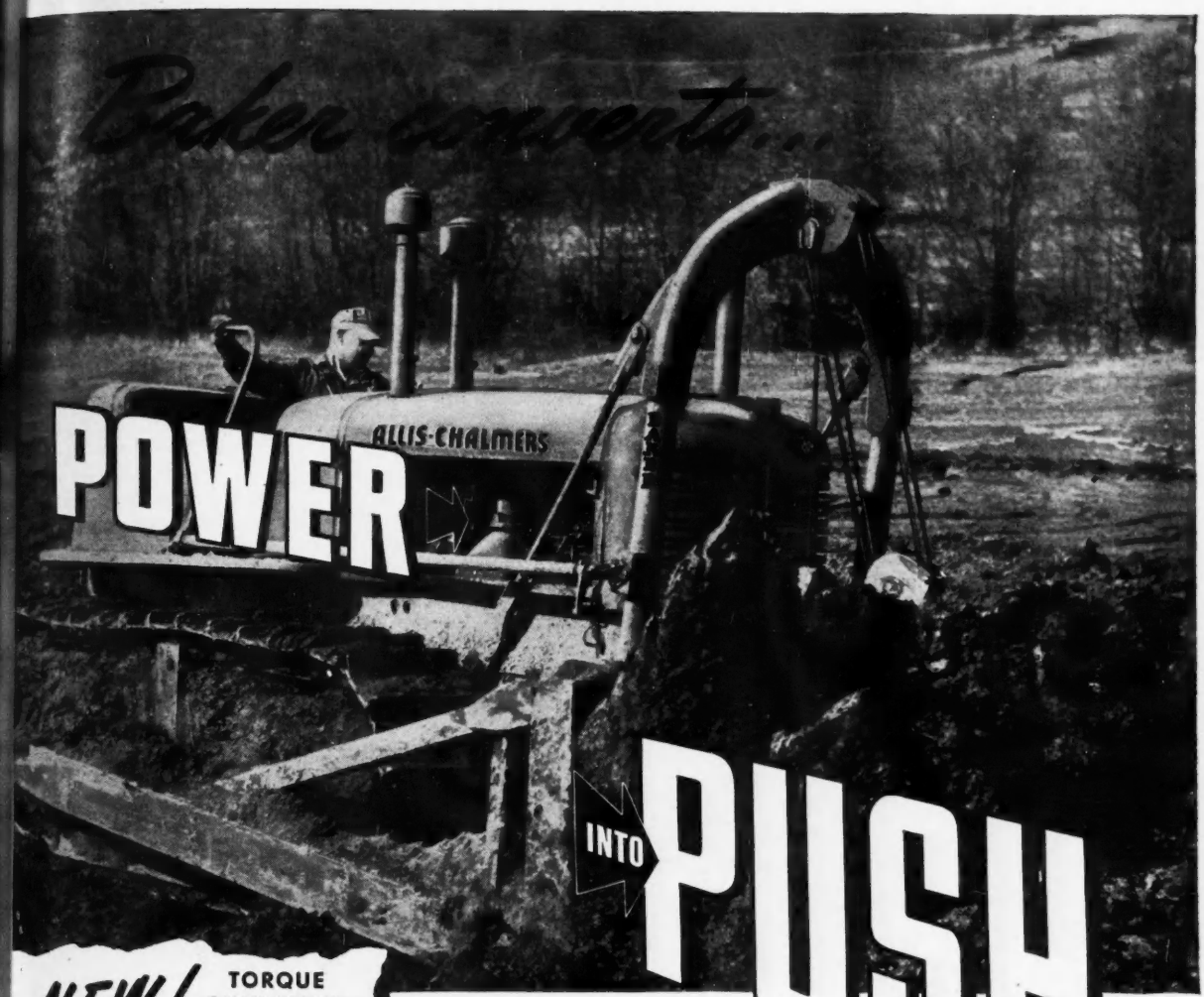
Lieut. Col. A. A. Anderson of Ottawa has been appointed district engineer for the Department of Public Works, Canada, at London, Ont., succeeding the late Harry F. Bennett. Col. Anderson has been with the Public Works Department for many years. He served as senior assistant engineer in the London office before the war, after which he was for a time attached to the chief engineer's staff at Ottawa. **D. H. MacDonald,** senior assistant engineer, has been acting district engineer since the death of Mr. Bennett six months ago.

Herbert C. Mode, engineer with Turner Construction Co. of New York since 1924, has been appointed director of personnel to provide opportunities for the firm's returning war veterans, employment and assignment of employes below the rank of department head; obtaining trained talent from educational institutions; and maintaining close contact with executives and heads of departments in the main and branch offices the most advantageous placement of employes.

D. H. Storms, engineer and former brigadier in the Canadian Army, has been appointed general manager of Housing Enterprises Limited, set up in Canada by leading life insurance companies to build, own and operate low-rental housing projects. Storms is a graduate of the Royal Military College of Canada. He served with distinction in the first world war. On his return he took his degree in civil engineering at the University of Toronto and then entered the construction field. For some years he was president and general manager of the Storms Contracting Co., and of the Bituminous Spraying Contracting Co. He went overseas in 1941 as lieutenant colonel in command of the 4th Battalion, Royal Canadian Engineers, rose to brigadier and was retired from the army last July.

N. W. Hicks, construction engineer for the North Dakota State Highway Department, has resigned from that post, where he had been employed since 1938. He previously was a division engineer and acting chief engineer for the Montana State Highway Department.

Maj. W. Allen Stone, former city engineer at Cincinnati, Ohio, has been appointed chief engineer on sanitation projects at Chimbote, Peru, where he has been stationed for more than a year. The current project includes establishment of medical services in the interior regions of Peru and building of sanitation works at Chimbote, planned as a new national industrial center. Major Stone received his appointment from the Division of Health and Sanitation of the Institute of Inter-American Affairs, which is carrying on this undertaking.



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More traction, more power, more speed — more yardage. Get the facts on this great new development — the HD 14-C equipped with a Baker 'dozer.

Baker bulldozer design applies the FULL power of the tractor to the load. Correctly mounted, perfectly balanced, soundly designed, and cooperatively engineered with Allis-Chalmers, Baker cable and hydraulic 'dozers assure maximum yardage from every tractor.

Baker design keeps the tracks on the ground, uses the full weight and power of the tractor to develop push on the blade. You get deeper penetration, smoother operation and more yardage per shift, when a Baker digs in. That's why there are more Baker 'dozers mounted on A-C tractors than all others combined.

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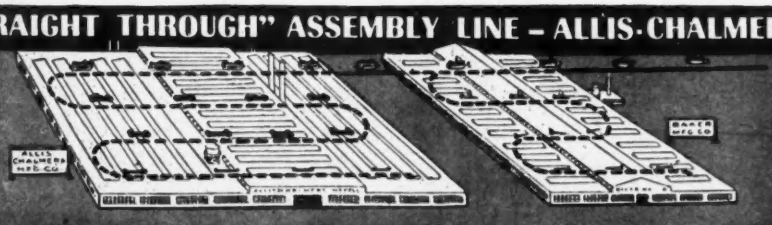
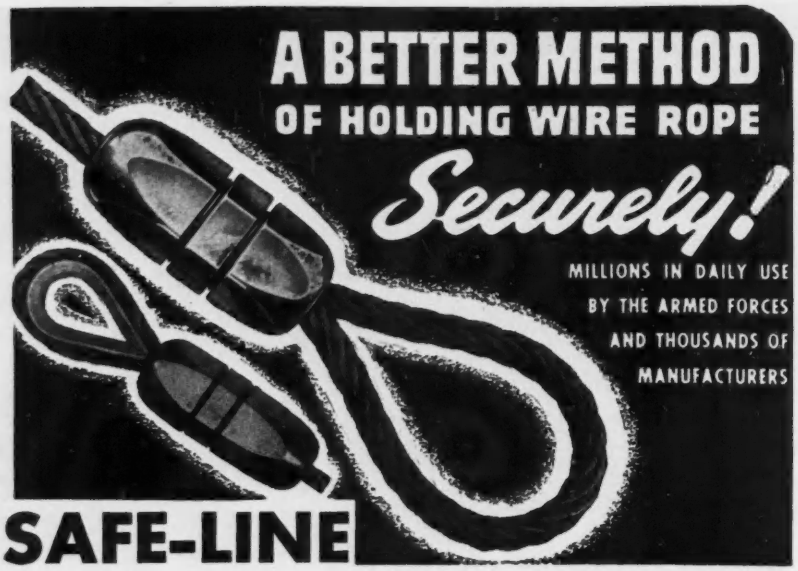
BAKER MFG. CO. SPRINGFIELD, ILL.

"STRAIGHT THROUGH" ASSEMBLY LINE – ALLIS-CHALMERS TO BAKER TO YOU!



This modern Baker plant with its completely equipped fabricating, machining and blacksmithing shops adjoins the Allis-Chalmers crawler tractor plant. When you order an A-C tractor with Baker bulldozer or gradebuilder, your tractor leaves the A-C assembly line, crosses a narrow court and goes on the Baker final assembly line.



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FOR ROPE SIZES 1/8" TO 3/4"

Never Slips

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Double spiral splines fit each wire and strand, provide a perfect, secure GRIP on rope. Pressure equally distributed over large area eliminates cutting action. Locking lugs automatically line-up threads.

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Much faster—saves time—reduces cost. Minimizes rope or sling breakage. Holds tight thimble.

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No highly skilled labor or special tools required. Easy to adjust as rigging stretches.

Outpulls Strongest Rope—Never Slips

¾" 6 x 19 Improved Plow Steel Wire Rope broke at 46,850 lbs. on Riehle Testing Machine. *Safe-Line held.*

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Thousands of the first SAFE-LINE Wire Rope Clamps made are still in use. Low initial cost.

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Needle-sharp wire ends enclosed inside clamp protects against cutting or scratching hands and arms. Smooth rounded shape prevents fouling.

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PLYMOUTH LOCOMOTIVES

• FROM 2½ TO 70 TONS •

PLYMOUTH LOCOMOTIVE WORKS

Division of The Fate-Root-Heath Co., PLYMOUTH, OHIO, U. S. A.

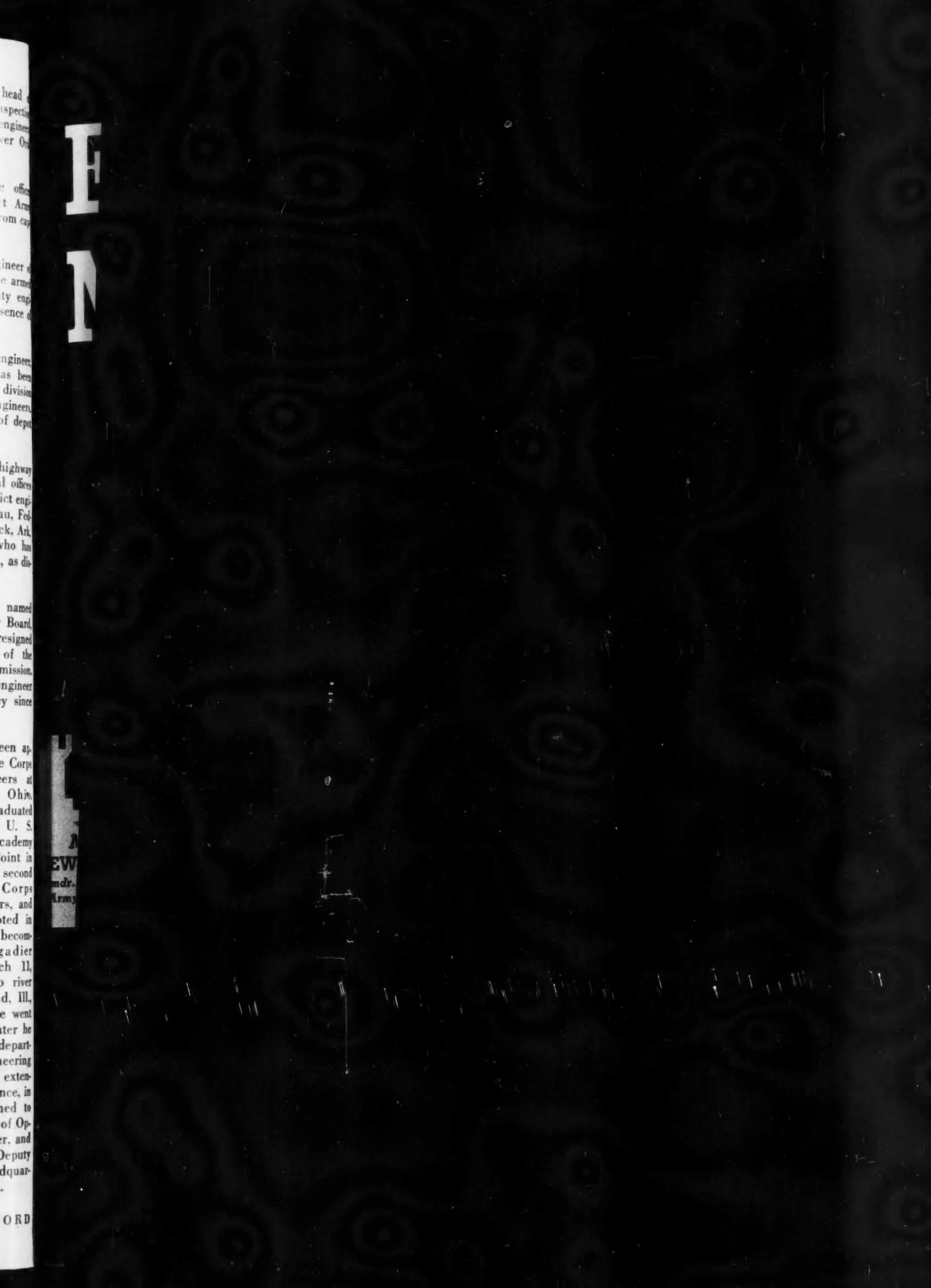
William H. Owen is now head of the field engineering and inspection department for the architect-engineer manager firm for the Sunflower Ordnance Works at DeSoto, Kan.

Horace H. Person, executive officer to the Portland, Ore., district Army engineer, has been promoted from captain to major.

Lt. Col. Cliff Bissett, city engineer of Dallas, Tex., now serving in the armed forces, will be back at his city engineering post soon, after an absence of over two years.

Maj. C. C. Templeton, civil engineer, formerly of Portland, Ore., has been appointed chief of the supply division for the Seattle District Army Engineers. He previously had been chief of depot supplies for the district.

Floyd R. Oliver, former senior highway engineer in the Texas divisional offices at Fort Worth, has become district engineer of the Public Roads Bureau, Federal Works Agency at Little Rock, Ark. He succeeds **John M. Page** who has been transferred to Austin, Tex., as district engineer for Texas.

Carl V. Youngquist has been named chief of the Ohio Water Supply Board, succeeding **David Harker,** who resigned recently to become director of the Indiana Flood Control Commission. Youngquist was Ohio district engineer for the U. S. Geological Survey since 1938.

Brig. Gen. B. C. Dunn has been appointed division engineer for the Corps of Engineers at Columbus, Ohio. He was graduated from the U. S. Military Academy at West Point in 1910, as a second lieutenant, Corps of Engineers, and was promoted in due course, becoming a brigadier general (temporary) on March 11, 1943. He was first assigned to river and harbor work at Rock Island, Ill., and Memphis, Tenn. In 1910 he went to the Panama Canal Zone. Later he was assistant professor of the department of practical military engineering at West Point. After varied and extensive military engineering experience, in December, 1943, he was assigned to Headquarters, European Theater of Operations as Deputy Chief Engineer, and in February, 1944, was named Deputy Chief Engineer of Supreme Headquarters, Allied Expeditionary Forces.